AN ASSESSMENT OF STORMWATER MANAGEMENT RETROFIT AND STREAM RESTORATION OPPORTUNITIES IN LINGANORE CREEK WATERSHED, FREDERICK COUNTY, MARYLAND

Prepared for

Frederick County
Division of Public Works
118 North Market Street
Frederick, Maryland 21701-5422

Prepared by

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Versar, Inc.
9200 Rumsey Road
Columbia, Maryland 21045

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ACKNOWLEDGEMENTS

This project was made possible through the contributions of additional Versar staff. Tom Jones helped identify candidate restoration opportunities and conducted field reconnaissance of candidate project sites with help from Peyton Emerson. Jodi Dew provided invaluable database and stormwater pollutant modeling support. Allison Brindley provided geographic information systems support for the pollutant load modeling effort.

Staff of the Frederick County Division of Public Works collaborated with Versar throughout this effort, providing a wealth of local knowledge that was invaluable. In particular, Shannon Moore, Kay Schultz, and Jessica Hunicke were instrumental in organizing and hosting the public workshop, and providing additional comments and insights on public interest based on their work in the watershed over the last few years.

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1.0 INTRODUCTION

Urban stresses on watershed health and resulting impacts to the quality of a watershed's streams are well documented (Table 1-1). To address these types of impacts, Frederick County continues to sponsor a series of studies in its high priority watersheds to identify watershed restoration projects that could improve and protect water quality and stream conditions. This report documents the findings of the Linganore Creek watershed restoration study conducted by Versar, Inc., under contract to the Frederick County Division of Public Works (Task Order Numbers 02-CSC-04-78764 and 02-CSC-04-78768).

Table 1-1. Major pollutants (stressors) in urban or suburban areas and their effect on streams (Fairfax County 2001)

Stressor	Source	Environmental Effect
Altered Hydrology	Conversion of forested/natural areas to impervious surfaces. Increases amount and rate of surface runoff and erosion.	Overall channel instability, habitat degradation or loss.
Nutrients (Nitrogen and Phosphorus)	Improper use (over application) of lawn fertilizers.	Stimulate algae blooms. May reduce sunlight reaching stream bottom, limiting plant growth. Rapid accumulation of dead algae decomposes aerobically, robbing other stream animals of oxygen.
Sediment	Poorly managed construction areas, winter road sand, instream erosion, bare soils.	Clogs gills of fish and insects, embeds substrate, reducing available habitat and potential fish spawning areas.
Channel Alteration	Concrete, metal and rip-rap stabilization of stream banks. Stream channelization, flood / erosion control.	Major habitat reduction/elimination, changes flow regime dramatically. Dramatic alteration of biological communities can cause Thermal Loading and Sediment problems. Transfer erosion potential downstream.
Riparian Loss	Development. Clearing or mowing of vegetation all the way up to stream banks.	Increase water temperature, greater pollutant input, less groundwater recharge, greater erosion potential from streambanks. Alters community composition.
Toxics	Various. Underground storage tank leakage, surface spills, illegal discharges, chlorine from swimming pool drainage, etc.	Can have an immediate (acute) affect on stream biota if levels are high enough. May be chronic, eliminating the more sensitive species and disrupting ecosystem balance over time.
Organic Loading	Sewage leaks, domestic and livestock wastes, yard wastes dumped into streams.	Human health hazard (pathogens), similar oxygen depletion situation as Nutrients. Causes benthic community shift to favor filter feeders as well as organisms with low oxygen requirements.
Thermal Loading	Water impoundments (lakes or ponds). Industrial discharges and power plants. Removal of riparian tree cover. Runoff from hot paved surfaces.	Biological community structure altered, shift to species tolerant of higher temperatures, sensitive species lost. Dissolved oxygen depletion.
Exotic Species	Human transportation and release (intentional and unintentional).	Invade ecosystem and out compete native species for available resources (food and habitat). Some introduced intentionally to control other pests.

1.1 LINGANORE CREEK WATERSHED STUDY AREA

The Linganore Creek Watershed in Frederick County, Maryland, is located immediately east of the City of Frederick (Figure 1-1). Linganore Creek, a network of 224 miles of stream, drains westward from just inside the edge of Carroll County to the Monocacy River. Linganore Creek's watershed encompasses 91.7 square miles; 91 percent (83.3 square miles) of which is located within Frederick County. This study examines the entire Frederick County portion of the Linganore Creek drainage area.

Linganore Creek has been classified by Maryland Department of the Environment (MDE) as Class IV, Recreational Trout Waters (FCDPZ 1998). The Creek is also one of the largest tributaries to the Monocacy River, a National Scenic River placed on MDE's 303(d) list of waters impaired by nonpoint source pollution (FCDPZ 1995).

Lake Linganore, located in the central portion of the lower watershed, is the largest non-mainstem impoundment in the Monocacy River basin (approximately 220 acres) and is used for recreation and water supply (FCDPZ 1998). The City of Frederick operates a water treatment facility that withdraws water from the Creek just downstream from Lake Linganore. The County operates a treatment facility with an intake 1,200 feet upstream from the Lake Linganore dam. A third drinking water intake is located immediately upstream of Lake Linganore and is operated by the Westwinds Country Club (FCDPZ 1993; 1995). Lake Linganore is listed on MDE's 303(d) list and Total Maximum Daily Loads have been established for sediment and phosphorus (MDE 2002b).

Major centers of development within the watershed include New Market, Libertytown, a portion of Mount Airy, the Spring Ridge development, and several communities surrounding Lake Linganore. Agriculture is the dominant land use within the watershed, especially in the northern and eastern portions; however, much of the land in the southern part of the watershed, along the I-70 corridor, is classified as low-, medium-, or high-density residential. Current zoning maps indicate that a large portion of the area near Lake Linganore is zoned for Planned Unit Development (PUD).

Previous mapping by the County separated the watershed into two management units to facilitate assessment, planning, and restoration efforts over such a large area: Upper Linganore Creek watershed and Lower Linganore Creek watershed. The boundary between these two management units was based on topography, drainage patterns, and landuse, and is located west of MD Route 75, immediately below the confluence of Town Branch. The 2002 watershed characterization study for Lower Linganore Creek (Perot et al. 2002) divided the lower portion into 10 subwatersheds. As described in Appendix A, the upper portion of the watershed was similarly divided to facilitate analysis, thereby resulting in a total of 20 subwatersheds in Linganore Creek (Figure 1-2).

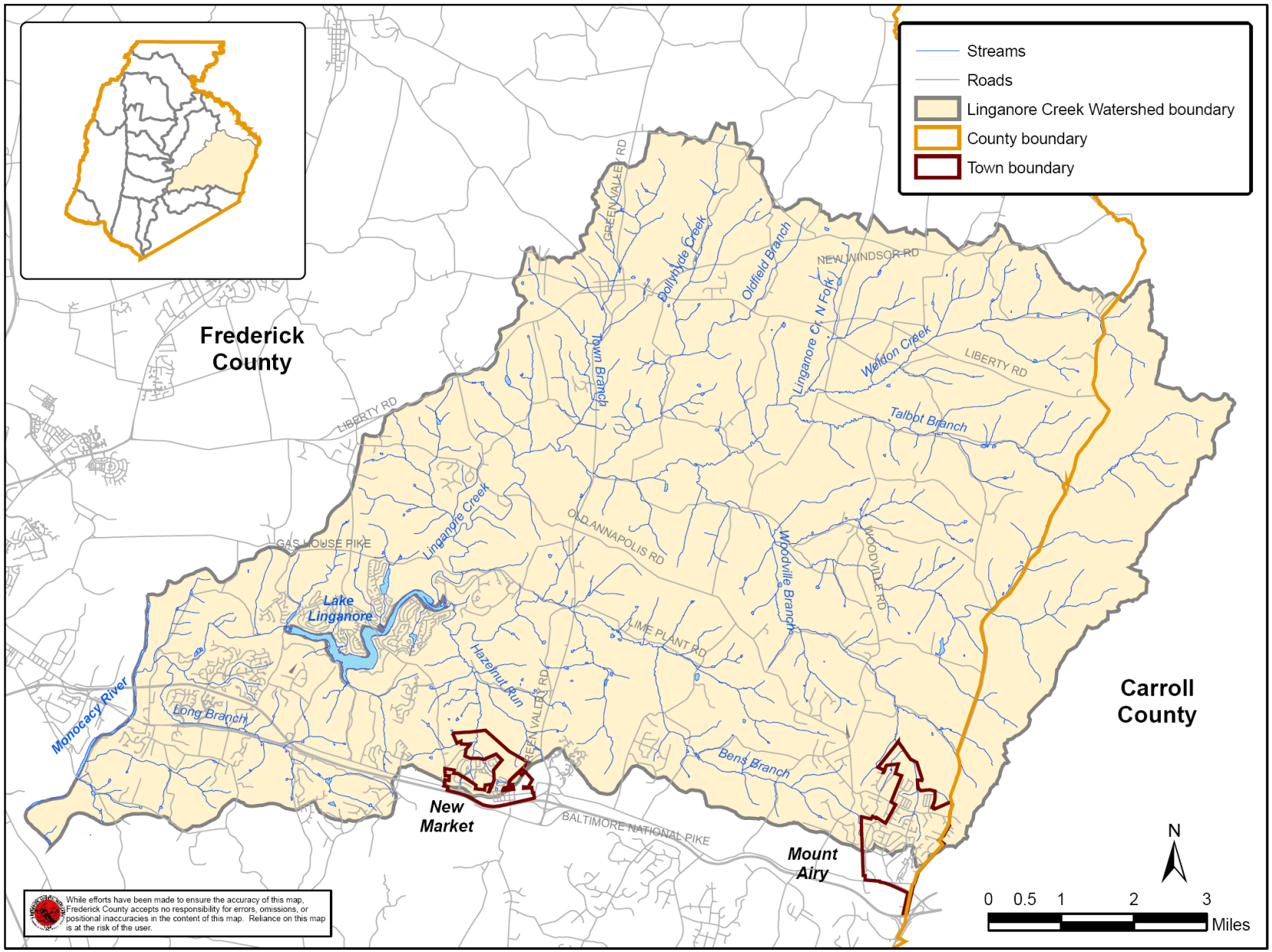


Figure 1-1. Linganore Creek Watershed, Frederick County, MD

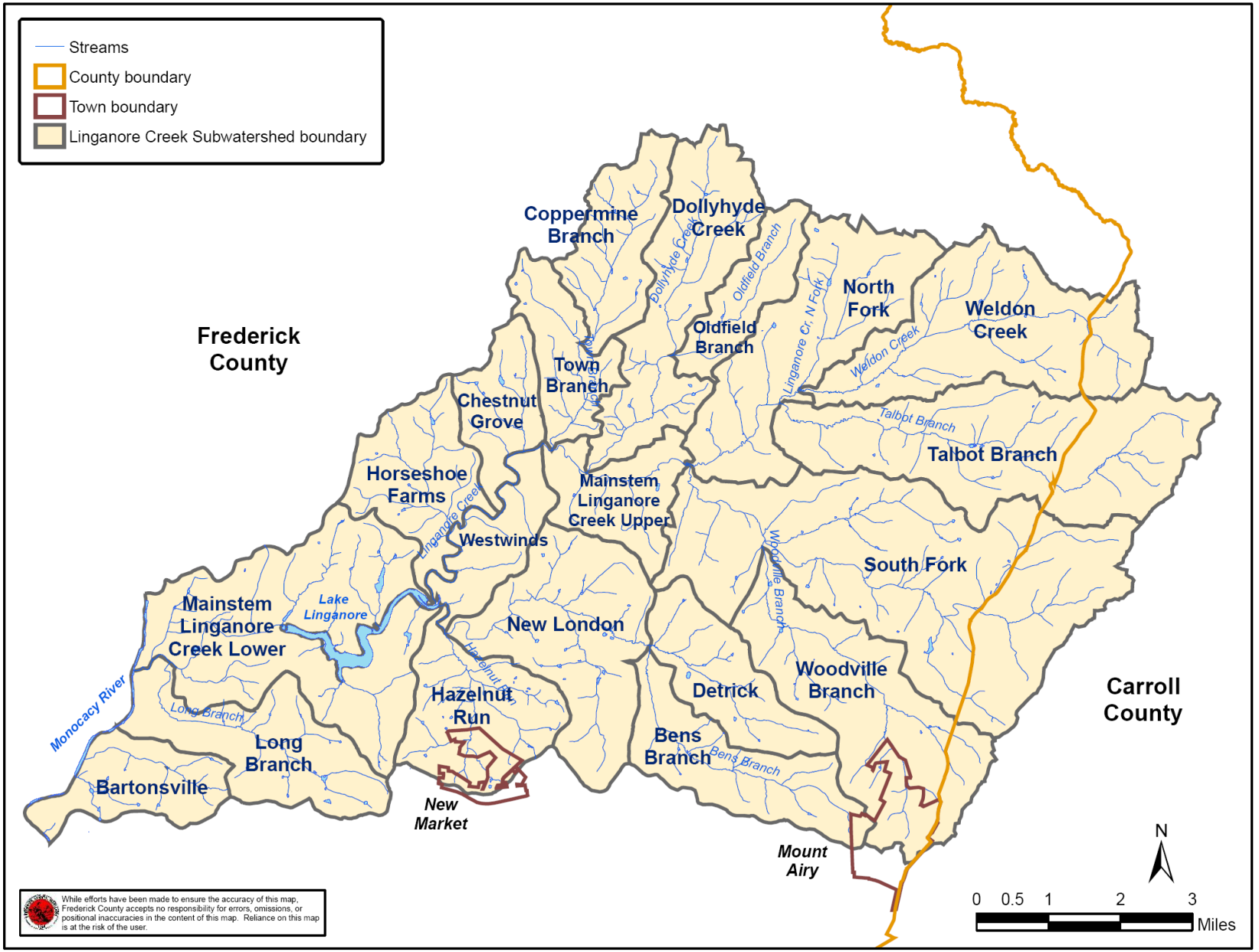


Figure 1-2. Subwatersheds delineated within Linganore Creek, Frederick County, MD

1.2 GOALS AND OBJECTIVES

Building upon previous efforts to assess watershed conditions and stressors affecting Linganore Creek (Perot et al. 2002, Czwartacki and Yetman 2004, Hunicke and Yetman 2005, Patterson and Yetman 2006), the goal of the study was to identify and evaluate specific opportunities for additional stormwater management (SWM) controls and stream restoration that could cost-effectively improve conditions in the Linganore Creek watershed. Utilizing the methods outlined below, Versar worked in collaboration with County personnel to: 1) use existing information to target efforts and solutions to the most promising areas, 2) use a model to estimate stormwater pollutant loads for the Linganore Creek watershed, 3) conduct field site investigations to refine proposed concepts for solutions, 4) host a public meeting to solicit input from local stakeholders, 5) develop a prioritization of opportunities, and 6) prepare this report containing recommendations and conceptual plans for the best watershed restoration opportunities.

At the outset of this project, the County identified a number of objectives and guidelines, as outlined below:

- To focus primarily on urban stormwater management improvements
- The best opportunities for addressing urban stormwater issues will
  - be located on County-controlled land or that originate on private property and impact County-controlled infrastructure
  - have synergies with Frederick County's existing Capital Improvement Program (CIP) projects
  - address or accommodate the genesis of the problem (i.e., increased volume and velocity of stormflow), and
  - have good visibility to encourage public acceptance of new and potentially innovative restoration measures.
- To incorporate public input into the problem identification and site selection process
- To target watershed restoration efforts to those areas that produce the highest levels of stormwater pollutants, as estimated by the stormwater pollutant loading model
- To estimate the amount of pollution reduction that would be provided by implementation of the selected projects
- Selected projects will likely be implemented through the County's CIP, which has minimum project requirements, namely projects must cost greater than $100,000 and have more than a 10-year life-span
- Opportunities for watershed restoration that do not meet the County's selection and implementation guidelines can be pursued via the County's extensive network of Community Restoration partners. Projects include urban stormwater management

improvements on private land, as well as implementation of agricultural best management practices (BMPs) in more rural areas.

Based on these guidelines, two types of projects have been identified: those that could be implemented through the County's CIP and those more suitable for implementation through the County's Community Restoration partners. To facilitate decision-making, a prioritized list of projects was developed to help focus implementation efforts, with detailed conceptual plans prepared for the best CIP opportunities; the remainder of opportunities, both CIP and Community Restoration, have been recorded for use as opportunities arise. While many of the individual projects identified in this study do not meet the minimum CIP cost threshold, grouping projects based on location (e.g., by subwatershed) and type will likely increase the benefit and efficiency of implementation, as well as exceed this minimum cost threshold.

An additional objective is to address the County's current National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit goal to provide treatment for 10 percent of impervious areas that are currently not served by stormwater management. Based on impervious estimates from the County's 2002 NPDES Annual Report, there are 207 untreated, urban, impervious acres within the County's portion of the Linganore Creek watershed. To this end, providing stormwater management controls for 21 untreated impervious acres would help satisfy the watershed's proportion of the County's overall 10 percent untreated goal.

It is also important to note that if left unchecked, many of the stormwater runoff and associated nonpoint source pollution problems noted in this study may lead to long-term impacts to the quality of Frederick County's water resources, as well as exacerbate regional water quality problems by contributing to cumulative impacts downstream in the Monocacy and Potomac Rivers, and ultimately in the Chesapeake Bay. Potential water resource impacts include:

- destabilization of drainage pathways and stream channels
- damage to infrastructure and private property from erosion
- reduction of drinking water quality and increased treatment costs for local water supplies, and if left untreated, potential public health and safety concerns
- reduction of the quality and diversity of physical habitat available to aquatic organisms
- reduction in species diversity and abundance within stream biological assemblages, including adverse effects from the proliferation of invasive, non-native species
- reduction in economic, social, and aesthetic benefits to local communities (e.g., tourism, recreational fisheries, sense of well-being, community identity, etc.), and
- economic burden associated with dredging accumulated sediments from Lake Linganore.

2.0 METHODS

In order to identify the best opportunities for stormwater controls and stream restoration within the study area, the project team used a restoration targeting approach used in previous watershed restoration studies in Frederick County (Perot et al. 2003, 2005) and elsewhere in the mid-Atlantic region (Southerland et al. 1999, 2000; Roth et al. 2002). This approach uses both existing data and new investigations, to carry out the following steps:

1. Determine general problem types and trends in stream condition
2. Develop criteria based on existing and new information to distinguish problem types
3. Identify areas or sites experiencing degradation and the most likely causes of those problems
4. Develop and apply criteria to rank candidate restoration sites
5. Recommend site-specific restoration measures

2.1 REVIEW OF EXISTING AND ONGOING WATERSHED STUDIES AND PROJECTS

As the first step toward characterizing general problem types and planning our subsequent investigations, we reviewed existing background information on the most significant problems affecting streams in the study area.

2.1.1 Lower Linganore Creek Watershed Assessment

A baseline study of watershed conditions in the Lower Linganore Creek watershed was completed in 2002 (Perot et al.), which characterized general watershed conditions, including land use, degree of imperviousness, location of stormwater management facilities, a visual assessment of watershed conditions, biological stream monitoring, estimates of current and future stormwater pollutant loads, and other information. Information from this study was used to better understand historical and planned growth patterns, stormwater management practices in different areas, stream conditions, and other watershed characteristics.

2.1.2 Lower Monocacy Watershed Restoration Action Strategy

In May 2004, Frederick County completed the Lower Monocacy Watershed Restoration Action Strategy (WRAS) process, a grant-based, watershed planning process involving significant stakeholder input (FCDPW 2004). This process was established by the Maryland Department of Natural Resources (MDNR) and was carried out using U.S. Environmental Protection Agency's (USEPA) Section 319 Clean Water Act funds. The purpose of the WRAS program is to protect water quality and habitat in priority watersheds within the State of Maryland, particularly those with listed impairments and Total Maximum Daily Load pollution

reduction requirements. This WRAS effort included a detailed assessment of three tributary streams to Upper Linganore Creek: Town Branch, Woodville Branch, and Talbot Branch.

The WRAS for the Lower Monocacy included several key MDNR work-products, including:

- Watershed Characterization, a document which compiles readily available and pre-existing data about the watershed (MDNR 2003)
- Synoptic Survey, using snapshot biological and chemical monitoring data to examine water quality and habitat; and (Primrose 2003)
- Stream Corridor Assessment (SCA), using field walks along stream corridors to map visible stressors and representative sites in Town Branch, Woodville Branch, and Talbot Branch (Czwartacki and Yetman 2004).

The WRAS also included extensive coordination on the part of the County and its broad-based steering committee of 40 individuals from 25 stakeholder groups to compile and analyze data and ancillary information. Among the activities completed in this process were two workshops to analyze the data gathered during stream corridor assessments and to identify priority sites for restoration along 75 miles of stream in the Bennett and Linganore Creek watersheds.

In addition, County staff and Steering Committee members hosted two public meetings in March 2004, one each in Bennett Creek and Linganore Creek watersheds, to share findings with the public and solicit their ideas as to issues and priorities for action. Public input from citizens, including agricultural and residential owners, was summarized in the WRAS plan (FCDPW 2004).

Subsequently, working groups of the Steering Committee developed recommendations for inclusion in the WRAS, and began planning and developing demonstration projects. Objectives/projects were developed in three subject areas for the WRAS plan: Natural Resource Management, Community Education and Outreach, and Issues Requiring Further Study.

Project opportunities identified in the WRAS, where relevant to the purposes of this study, have been reviewed and incorporated into this report.

2.1.3 Stream Corridor Assessment Surveys

Subsequent to the Lower Monocacy WRAS, Frederick County coordinated with the MDNR to conduct SCA surveys in the remaining portions of the Linganore Creek watershed to rapidly assess the general physical conditions of the stream corridor. SCAs are conducted by a trained team of AmeriCorps volunteers, who walk the streams and collect field data for observed environmental problems following a standardized method (Yetman 2001). Stream walks in

Linganore Creek were completed in three phases during 2003 through 2005, including the initial SCAs conducted during the Lower Monocacy WRAS, and results have been documented by the State (Czwartacki and Yetman 2004, Hunicke and Yetman 2005, Patterson and Yetman 2006). After the field work was completed for each SCA phase, SCA data were entered and organized into a database and a geographic information system (GIS). A summary of the results of environmental problems observed in the three SCA surveys in Linganore Creek is presented in Table 2-1. The SCAs also assessed 83 representative sites and provided 21 additional comments.

Table 2-1. Summary of environmental problems observed in the Linganore Creek SCAs.

Identified Problem	Number of Sites	Estimated Length	Very Severe	Severe	Moderate	Low Severity	Minor
Channel Alteration	40	2,251 feet (0.4 miles)	0	0	7	11	22
Erosion Site	129	236,391 feet (44.8 miles)	8	28	40	39	14
Exposed Pipe	7	N/A	0	0	1	2	4
Fish Barrier	104	N/A	0	8	18	10	68
Inadequate Buffer	202	Left bank: 368,265 feet (69.7 miles) Right bank: 378,298 feet (71.6 miles) Total length: 746,563 feet (141.4 miles)	61	30	39	43	29
Pipe Outfall	53	N/A	0	2	9	22	20
Trash Dumping	20	N/A	0	1	3	8	8
Unusual Condition	14	N/A	0	1	3	4	6
Total	569		69	70	120	139	171

2.1.4 Lake Linganore Community Development Authority

The Lake Linganore Community Development Authority (CDA) is currently working on a road and drainage improvement project within the Balmoral, Coldstream, Meadows, Pinehurst, and Nightingale villages. This project is nearing the construction phase, and is based on Low Impact Development design principles involving open section road designs, without curbs, that will encourage stormwater infiltration in roadside swales (LLCS 2005).

2.1.5 Total Maximum Daily Load Allocations for Lake Linganore

Section 303(d) of the federal Clean Water Act (CWA) and USEPA implementing regulations direct each State to develop Total Maximum Daily Loads (TMDLs) for all impaired waters on the State's Section 303(d) list. As approved by EPA in 2003, MDE has established TMDL allocations for the nutrient phosphorus and sediment entering Lake Linganore. The

annual load for phosphorus is set at 5,288 pounds/year and for sediments is set at 7,073 tons/year. Of these annual loads, 4,150 pounds/year of phosphorus, and 6,346 tons/year of sediment are allocated to nonpoint sources (MDE 2002a, MDE 2002b). The TMDL does not establish a separate Waste Load Allocation for stormwater management facilities managed under the County's NPDES MS4 permit; therefore, these facilities are subject to the phosphorus and sediment load restrictions placed on non-point sources. MDE (2002b) estimates that a 90% reduction of phosphorus, and a 45% reduction in sediment, from nonpoint sources will be needed to meet the TMDL.

The water quality goal of these TMDLs is to reduce long-term phosphorus and sediment loads to acceptable levels consistent with the physical characteristics of Lake Linganore. This reduced phosphorus loading rate is predicted to resolve excess algal problems and maintain a dissolved oxygen concentration above the State's water quality standard. For sediments, the TMDL is established to achieve a loading rate consistent with the uses of the lake. This loading rate is estimated to result in preserving about 48 to 79 percent of the lake's design volume over a period of 40 years (MDE 2002a, MDE 2002b).

2.1.6 Drinking Water Task Force on Lake Linganore

In 2002, the Board of County Commissioners and the City of Frederick endorsed the creation of the Linganore Source Water Protection Plan (Frederick County Division of Planning 2004). Work on the plan began through the Environmental Finance Center of the University of Maryland, which was awarded funding by the USEPA to address the issue of source water protection in a unified or resource-based manner. A task force, consisting of Federal, State, County, and City officials, Lake Linganore community residents, farmers, regional non-profits, and others, was formed. Over a two-year period, the task force collectively pooled their knowledge and expertise to craft a suite of recommendations to protect the water quality and quantity of Lake Linganore.

In November 2004, the Board of County Commissioners accepted the Linganore Source Water Protection Plan, which includes recommendations and implementation strategies for five main focus areas, including: Land Development, Agriculture, Homeowner Practices, Infrastructure and Maintenance, and Outreach/Education (Frederick County Division of Planning 2004). As directed by the Board of County Commissioners, staff recently developed an action plan to guide the implementation of the many recommendations made in the report (FCDP 2006). This action plan identified specific action items, responsible agencies, and implementation timeframes for a range of programmatic, education, and management improvements in the Lake Linganore basin.

2.1.7 Liberty Stewards Project

Frederick County secured $25,000 in grant funding from the Chesapeake Bay Trust (CBT) for three or more community restoration projects in Libertytown in the Town Branch subwatershed. The following actions are underway via the project.

Liberty Village Rain Gardens: Liberty Village Co-housing Community is a residential community that adjoins Libertytown Park; the park contains a wetland and a tributary to Town Branch. The homeowner association agreed to participate by helping install and plant two rain gardens on its property. The first garden covers 420 square feet and was designed by the Potomac Conservancy, a project partner. It will treat a drainage area of approximately ¼ acre with 45 percent impervious cover. The garden was installed on November 30, 2005, and includes nine native shrubs. Herbaceous plantings were installed during April and May 2006. Members of Liberty Village were required to sign maintenance agreements as a stipulation for project funding. The homeowner association has requested assistance with a two additional rain gardens on its property.

Liberty Elementary School Rain Garden: The Liberty Elementary School principal, staff, and Parent Teacher Student Association (PTSA) approved the installation of a 500-square-foot rain garden designed to treat approximately ¼ acre with 72 percent impervious cover. Potomac Conservancy designed the rain garden; installation occurred during spring 2006. Two local Master Gardener volunteers and Cub Scout Pack 1062 participated in the planting and have committed to assist with maintenance.

Stream Buffer Restoration on Town Branch at St. Peter the Apostle Roman Catholic Church: The MDNR Forest Service designed a Forest Stewardship Plan for the church's property through which Town Branch flows. The plan includes planting 600 linear-feet of a 35-foot-wide buffer with 185 native trees and 200 native shrubs. The church has agreed to the plan and an Eagle Scout will be managing the planting process during fall 2006. Twenty community volunteers will assist the Eagle Scout during the planting process.

2.1.8 Holding Our Ground: Water Quality and Stewardship in Linganore Watershed

The National Fish and Wildlife Foundation (NFWF) is providing $40,000 in funding to improve water quality in the Linganore Creek watershed by facilitating installation of five miles of riparian buffer and providing educational initiatives targeted to increase stewardship ethics among watershed citizens. The County will develop a GIS-based Watershed "House Call" Program template, target properties for analysis, and conduct on-site presentations. Pre-visit analysis, mapping, and on-site "House Calls" will analyze a minimum of 750 acres of riparian properties, roughly divided in half between developed and agricultural areas. The County will continue to update its landowner tracking database of riparian property owners and their participation in the program. Quarterly E-newsletters will be published to further promote watershed stewardship.

2.1.9 Linganore Creek TMDL - Urban Demonstration Project

MDE has awarded the County a $216,237 grant for its Linganore Creek TMDL - Urban Demonstration Project under the USEPA 319 (h) program. The Urban Demonstration Project, anticipated to begin during 2006, is a comprehensive treatment of urban nonpoint source pollution. In this project, key landowners will be targeted and offered increased technical assistance in the design and installation of BMPs for sediment and phosphorus control. The project will support enhancing riparian-forest buffers and using on-site approaches to reduce nonpoint source pollution.

The project anticipates creating demonstration BMPs to treat 30 acres of urban land, and establishing approximately 3 miles of riparian buffer that would encompass 18 acres and effectively treat a total of 36 acres. Project sites will include schools, regional parks, golf courses, and other publicly owned property. Interpretive signs will be posted to help citizens learn about the restoration projects and the benefits associated with improved stormwater management.

2.2 STORMWATER POLLUTANT LOAD MODELING

Differences in topography, soils, land cover/land use, and existing SWM controls often result in non-uniform contribution of stormwater pollutants across the landscape. As a result, runoff and pollutant loads can be disproportionately higher in some catchments. To help identify these areas, and target watershed restoration efforts to where they could provide the greatest benefit, Versar modeled stormwater pollutant loads in the Linganore Creek watershed (Schreiner et al. 2006; Appendix A). This effort updated previous modeling efforts for Lower Linganore Creek watershed (Perot et al. 2002) using more recent land use data, and extended the model into the Upper Linganore Creek watershed, including those portions located in Carroll County.

Estimates of stormwater pollutant loads and peak flow were used to aid prioritization of candidate restoration projects, as described in Section 2.6. The model also served as a basis for analysis presented in Section 5, which examines the potential pollutant reductions associated with recommended projects.

2.3 GIS MAPPING AND MAP REVIEW

Versar compiled an extensive collection of spatial data from the County and other public sources characterizing features of the Linganore Creek Watershed (Table 2-2). Mapping spatial data in a GIS was critical to this effort, combining a wide range of discrete data to help the project team integrate existing data and identify potential opportunities for improving stormwater controls and stream conditions in the watershed. To help identify these opportunities for watershed improvements, a series of large format maps were produced so that the project team could review site details and mark locations on the maps. To aid in reviewing site conditions, the County's orthophotography (from March 2000) was overlain with stormwater piping network

information (completed in 2004) and printed as an indexed map book at a scale sufficient to view conditions on the ground.

Table 2-2. GIS data layers utilized to help identify potential stormwater retrofits and stream restoration opportunities

Feature	Source	Feature	Source
Property boundaries	MD Property View 2004 tax maps	County owned property: schools, parks, unimproved land	Frederick County
Roads & bridges	Frederick County	Streambank erosion	MDNR SCA
Hydrography	Frederick County	Inadequate riparian buffer	MDNR SCA
SWM facilities	Frederick County	Stream habitat rating	MDNR SCA
Stormwater ponds	Frederick County	Fish barriers	MDNR SCA
Stormwater drainage networks	Frederick County	Pipe outfalls	MDNR SCA
Stormdrain inlets and outfalls	Frederick County	Habitat condition	MDNR SCA
Orthophotography	Frederick County	Exposed pipe	MDNR SCA
Non-County owned parks	Frederick County	Channel alteration	MDNR SCA
County, City and Town boundaries	Frederick County	Properties denied sampling access during SCA	MDNR SCA
Subwatershed and model catchment boundaries	Versar, Inc.		

Versar's project team of engineers and environmental scientists utilized mapped information from the SCA and aerial photographs to identify impacted stream reaches. Once an impacted area was identified and opportunities for improvement were noted, the project team looked to upstream or nearby upland areas to evaluate potential causes of the impacts. Potential improvements to these upstream/upland areas that could alleviate downstream stresses were noted, along with specific opportunities for restoration within the stream corridor itself.

2.4 WORKSHOP TO GATHER PUBLIC INPUT

A public workshop was held on February 23, 2006 at New Market Elementary School to provide an overview of the County's study, identify public concerns (e.g., frequent flooding, poor aesthetics, pollution, etc.), and solicit public input for identification of restoration and SWM opportunities. Meeting announcement and presentation materials have been included in Appendix B. The meeting was attended by County and project team staff, Community Restoration partners, and approximately 20 private citizens. Meeting participants were receptive to the general types of restoration and retrofit approaches presented at the meeting. In addition, meeting participants made a number of specific suggestions, as summarized in Table 2-3. Issues and opportunities obtained from the public were examined by the project team and incorporated into the map review and project identification process.

Table 2-3. Summary of comments received at the February 23, 2006 public meeting		
Suggestion Number	**Description of Problem**	**Associated Candidate Projects**
101	Landowner has a pond and stream running through 15 acres – wants to know what to plant along stream.	SF111
102	Landowner would like to learn more about CREP program for Baltimore Presbytery property; currently non-profitable cropping on parcel off MD Route 75	NL112
103	Comment is a correction to County's GIS stream layer: add perennial spring to property. Also spring on Detrick Road needs to be added – connects to residential area (edits hand drawn on map).	-
301	Clogged road culvert – water and ice on road led to wreck; erodes and drops sediment on landowner's property.	directed to Highway Operations for correction
302	Eroded stream banks; instream erosion problem.	HF107
303	Twelve cows – may be potential for some riparian planting; grassy area along stream; upstream of site 302; possible road drainage problem from Old Annapolis Road runoff.	HF103
General Comments Received		
	25-acre rural lots splitting good farm lots. New farmettes have livestock like horses and llamas, and are destroying land	
	Cover crop planting dates for state don't work well for Frederick farmers – they should be able to harvest cover crop for grain; if they are not raising livestock, then they are losing money. Have to put manure somewhere, so better with cover crop than no cover crop.	
	Landowner wants Alliance partner signs	
	IPP program (a county agricultural preservation program) needs to establish values for different areas of County (i.e., New Market more valuable than Thurmont)	
	Catch ponds – what do we do when they get full?	
	Avian coliform, nutrients from Canada geese – huge problem. Geese also destroy crops.	

In addition, the Frederick County NPDES Program maintains a database of public comments and concerns relating to watershed issues. The County and Versar staff reviewed comments provided previously by the public for areas within the Linganore Creek watershed and have incorporated many of those in this study.

2.5 FIELD VISITS

To further evaluate opportunities for watershed improvement and collect data to support the identification of candidate restoration sites, Versar staff conducted detailed visual inspections of many of the identified candidate sites from December 2005 through March 2006. During these site visits, the project team evaluated factors such as existing stormwater management structures and other BMPs, site drainage pathways, property ownership and uses, site layout for locating

new controls, utilities and other site constraints, land uses for potential water pollution sources, hydraulic/hydrologic problems, stressed vegetation, and stream stability to identify specific improvement opportunities.

2.6 PRIORITIZATION OF CANDIDATE PROJECTS

The aforementioned steps enabled the project team to identify 167 candidate project sites throughout the watershed. While many of these opportunities have been identified as localized points, more than half represent opportunities along a linear corridor (i.e., along a stream). Once candidate sites had been identified, project staff engaged in an in-depth process for prioritizing potential candidate projects in the watershed.

The prioritization process was similar to that employed in Ballenger Creek Watershed (Perot et al. 2005), with modifications to incorporate data on modeled catchment contributions obtained from the stormwater pollutant load model (SWMM). This ranking method was developed using categories of potential non-point source site problems, point source water quality and habitat site problems, and physical and cultural geographic considerations. Non-point source water quality problems were ranked based on the relative estimated pollutant loads for the model catchment containing the project site, represented by the amount of nutrients, sediment, and runoff generated within the catchment, and on the project site's potential to contribute excessive runoff volume or rate, sediment load, and pollutants to the flow. Potential point source water quality and habitat site problems were ranked, including pipe outfalls, exposed pipes, site specific bank erosion, channel alteration, fish barriers, site specific inadequate riparian buffer, and generally poor habitat conditions. Physical and cultural geographic considerations - geographic extent of the problem, educational impact, expressed citizen concerns - were also ranked.

In general, a three-point numerical rating was assigned to each criterion, with 1 being low and 3 being high, with a higher score resulting in a greater priority for implementation. SCA ratings of Moderate, Severe, and Very Severe were assigned a 1, 2, or 3, respectively.

The modeled catchment conditions category scores were based on the results of the stormwater pollutant loading model for the model catchment containing the candidate project site. Annual loading estimates (lbs/acre/yr) for nitrogen, phosphorus, TSS, and an estimate of the peak flow (cfs) stemming from the model catchment, were assigned low, moderate or severe scores of 1, 2, or 3, respectively, as shown in Table 2-4.

Table 2-4. Numerical ratings based on stormwater pollutant load estimates

Parameter	**Low** (1)	**Moderate** (2)	**Severe** (3)	**Units**
Total Nitrogen	< 4	4 to 6	> 6	lbs/ac/yr
Total Phosphorus	< 0.5	0.5 to 0.7	> 0.7	lbs/ac/yr
Total Suspended Sediment	<250	250 to 350	> 350	lbs/ac/yr
Peak Flow	< 150	150 to 300	> 300	cfs

Scores for geographic considerations were assigned as follows:

- Relative extent of the problem (Extent) – localized problems = 1; widespread = 3
- Opportunity for Educational Benefits (relative number of individuals that would be exposed to educational aspects of the project) – minor (e.g., a few individuals) = 1; major (e.g., large number of individuals/groups) = 3
- Public Interest (project addresses citizen input received through the public workshop and other sources during course of project) – minor improvement of concern = 1; major improvement of concern = 3.

Based on these ratings, category totals were then adjusted according to the percent weight and rank scores listed in Table 2-5. Candidate projects and their ranking scores for each factor are listed in Appendix C. Total scores for the candidate sites are based on a maximum score of 100%.

Table 2-5. Summary of candidate project site prioritization weighting and ranks

Prioritization Categories and Sub-Categories	**Percent Weight**	**Number of Sites in Rank**		
		Score 1	**Score 2**	**Score 3**
Modeled Catchment Condition	15	*Low*	*Moderate*	*High*
Total nitrogen (lbs/acre/yr)		39	93	35
Total phosphorus (lbs/acre/yr)		46	93	28
Total suspended sediment (lbs/acre/yr)		49	88	30
Peak flow (cfs/yr)		15	102	50
Non-Point Source Site Problems	20	*Low*	*Moderate*	*High*
Runoff Volume and Rate		34	39	30
Sedimentation		35	64	19
Pollutants		74	79	13
Point Source and Habitat Site Problems	20	*Moderate*	*Severe*	*Very Severe*
Bank Erosion		29	49	26
Exposed Pipe		1	2	0
Pipe Outfall		5	15	1
Inadequate Riparian Buffer		1	18	88
Fish Barrier		1	4	2
Habitat Condition		3	11	32
Channel Alteration		6	2	1
Geographic Considerations		*Low*	*Moderate*	*High*
Extent	20	63	65	39
Educational Benefit	15	122	26	18
Public Interest	10	6	3	38
Total	100			

Subsequently, in consideration of the County's ownership and other requirements for the best opportunities to address urban stormwater impacts (Section 1.2), we divided the 167 sites into the following two groups: CIP projects and Community Restoration (CR) projects.

Ownership information on these sites was reviewed using a combination of MD Property View 2004 GIS data and on-line real property databases maintained by Maryland Department of Assessments and Taxation and the Maryland State Archives (MDAT undated, MSA 2006). Given the potential for changes in ownership over time, this property ownership information should be considered preliminary and should be verified before initiating projects at these locations.

The list of candidate CIP projects was further reviewed to highlight the best opportunities for implementation. Review of the Total Scores for candidate CIP projects identified an apparent natural break in scores between 56% and 60%. Therefore, sites that received a score greater than 60% were considered the best opportunities for implementation and were identified as Tier 1 sites. The remaining candidate CIP sites, which still present good opportunities for watershed restoration were placed into a Tier 2 list of sites.

The candidate sites and project opportunities are presented in Section 4.

3.0 WATERSHED RESTORATION APPROACHES

Addressing the effects of urbanization on watersheds can be a challenging issue, primarily because traditional stormwater management approaches can be difficult to build into a built-out environment. Often, site constraints such as current use and space limitations, property ownership, cost, public acceptance, and long-term maintenance responsibility are barriers to effectively retrofitting SWM controls into existing urban settings. However, a number of approaches exist that can be used individually, or in an integrated combination, to work around these challenges and provide improved stormwater controls.

Our country has a rich agricultural heritage that is a major defining element of our communities, a point that is especially true in Frederick County. Although innovations and improvements have abounded in agricultural sciences, many historic practices adversely affected the quality and health of our water resources. To address the effects of these historical practices, a multitude of approaches, and resources, have been developed to aid the agricultural community's efforts to enhance watershed protections.

The following is an overview of watershed restoration approaches that can be implemented in urban or agricultural settings, the details of which can be customized to meet individual site requirements.

3.1 RESTORATION OPTIONS

Watershed restoration approaches fall into six basic categories:

- **New SWM ponds** – placement of new stormwater management ponds into locations that currently have no stormwater quantity or quality controls
- **SWM pond retrofits** – modifying existing SWM ponds to provide additional quantity or quality controls
- **Low impact development (LID)** – LID approaches are innovative practices designed to mimic natural flows by reducing the volume of stormwater runoff at the source, not merely in managing flows as they leave a site. Distributed LID features are a series of smaller landscape features that function as retention/detention areas integrated into developed areas. These features are designed and constructed to detain and treat stormwater through natural processes such as infiltration, soil storage, and uptake by vegetation. For the practices noted below, special attention should be paid to the composition of existing soils, as well as new soils or amended soils used. These solutions are increasingly being used to reduce stormwater-related and other adverse urban environmental impacts in developed areas (in addition to their incorporation into new development).
- **Stream restoration –** physical modifications to stream channels, banks, and instream habitat to repair or improve degraded and unstable conditions

- **Buffer enhancement –** replanting streamside vegetation with native species to improve the vegetated community, which buffer, or insulate, streams from a wide range of land use stressors
- **Agricultural BMPs –** a wide range of soil and water conservation, water quality, nutrient management, herd health, and agricultural preservation practices developed for use in agricultural settings

Additional information on these approaches follow.

3.1.1 New Stormwater Ponds

Description: Creation of a new stormwater pond to provide detention and water quality controls in areas where a pond does not currently exist. While sufficient space for this option may be difficult to obtain in built-out settings, the resulting benefits to flow volume and velocity control, and water quality improvement can be significant. Benefits may vary depending on the specific design features of the individual ponds.

Maintenance: The maintenance requirements of traditional stormwater ponds are well known. A typical pond is inspected by County personnel trained in dam safety and pond maintenance, looking at the dam, pipes, and riser structure to ensure it is functioning properly and not failing. Additional items that need to be inspected are any pretreatment facilities for clogging by sediments and large debris items. If sediments or clogging is evident, the area needs to be cleaned.

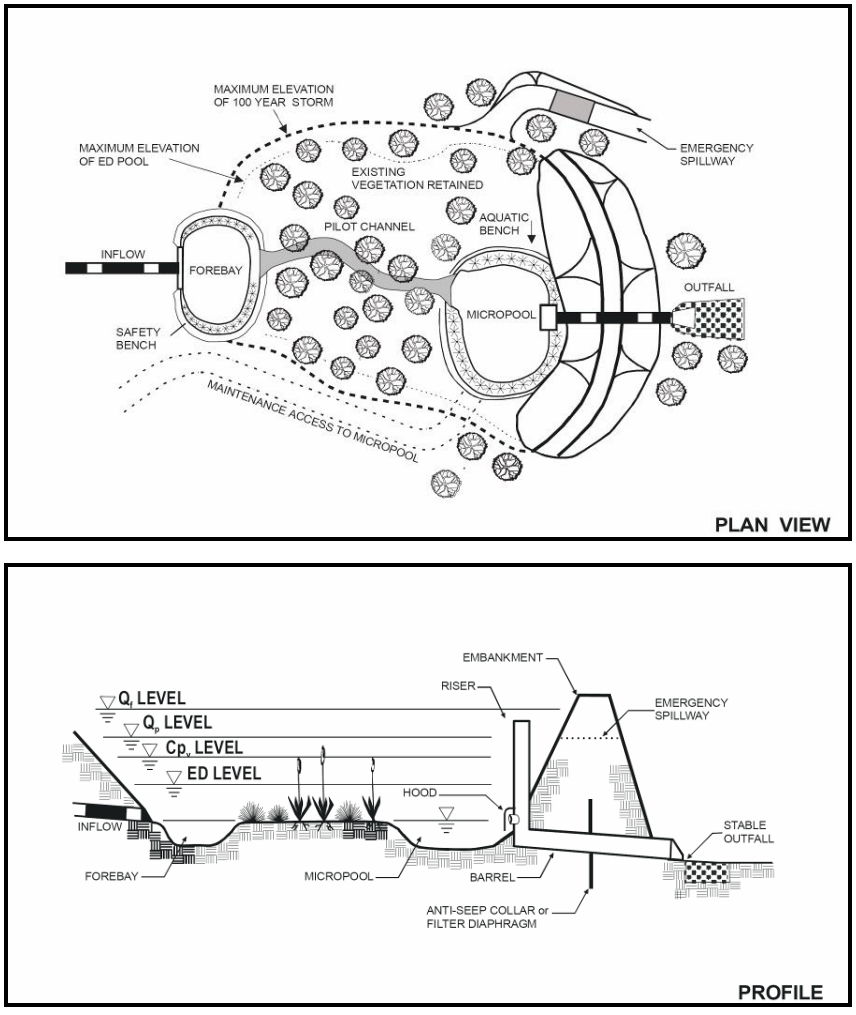


Figure 3-1. New Stormwater Pond ("Micropool" Extended Detention Pond shown)
(Source: MDE 2000a)

3.1.2 Stormwater Pond Retrofit

Description: Options for retrofitting existing SWM ponds (AMEC 2005) that may be suitable for implementation include:

1. Increasing detention storage by means of additional excavation and grading.
2. Providing water quality improvements to facilities that currently only provide water quantity control. These facilities could be retrofitted to also provide water quality treatment by means of installing a micropool, sediment forebay, constructed stormwater wetlands, or by increasing the surrounding riparian buffer.
3. Modifying or replacing the existing riser structure and outlet controls to further reduce the discharge rate from the storm water management facility. A riser is a structure, typically made of concrete with a metal grate on top, which controls the level of water in the stormwater pond.
4. Adding infiltration features such as sand filters or bioretention to promote greater peak flow reduction, groundwater recharge, and improve water quality treatment. A soil survey of the existing facility would be required to verify that this retrofit is suitable. Stormceptors, or equivalent LID products, could be installed in parking lots or other areas with a large percentage of impervious area. These devices are placed in the manhole and trap sediments and petroleum products before they flow into the pond.

Maintenance: The maintenance requirements of a retrofitted pond are not significantly more than a traditional stormwater pond. A typical pond is inspected by County personnel trained in dam safety and pond maintenance, looking at the dam, pipes, and riser structure to ensure it is functioning properly and not failing. Additional items that need to be inspected are any pretreatment facilities for clogging by sediments and large debris items. If sediments or clogging is evident, the area needs to be cleaned. If manufactured LID devices are used, manufacturer's maintenance recommendations need to be followed to ensure that devices function as designed.

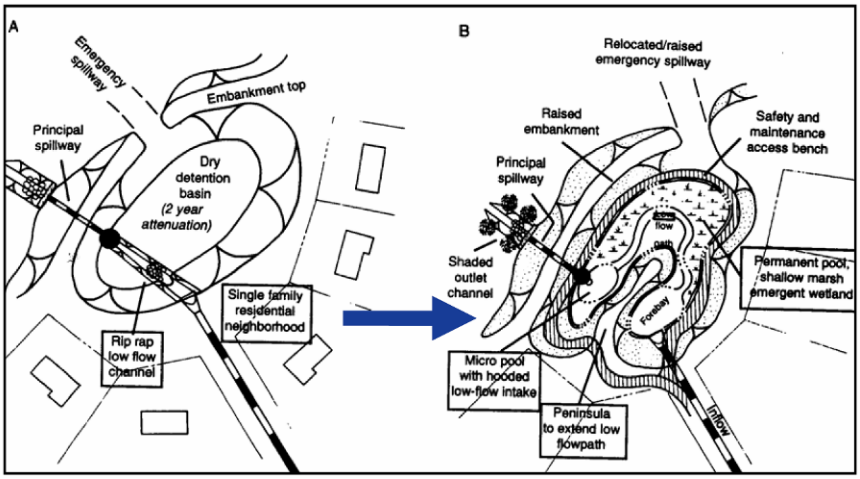


Figure 3-2. Stormwater Pond Retrofit (A. pre-retrofit pond; B. retrofitted pond)
(Source: Schueler and Holland 2000)

3.1.3 Culvert Retrofit

Description: This stormwater retrofit option is installed upstream from existing road culverts by constructing a control structure and excavating a micropool. These projects are designed only for intermittent or ephemeral streams. The control structure will consist of a gabion or concrete weir that will detain and reduce stormwater flow; the micropool is a small pool that will infiltrate the first 0.1 – 0.2 inches of stormwater runoff, improving both water volume/velocity and water quality (AMEC 2005).

Maintenance: Maintenance of the micropool area is very minimal. The area needs to be inspected for large debris or sediments that may be clogging the area, dead or stressed plants, and erosion around the weir. Remove large debris, built-up sediments, and replace dead or stressed plants as necessary. If there is erosion around the weir, the area needs to be inspected and stabilized as necessary. These facilities have an expected life span of 25 years.

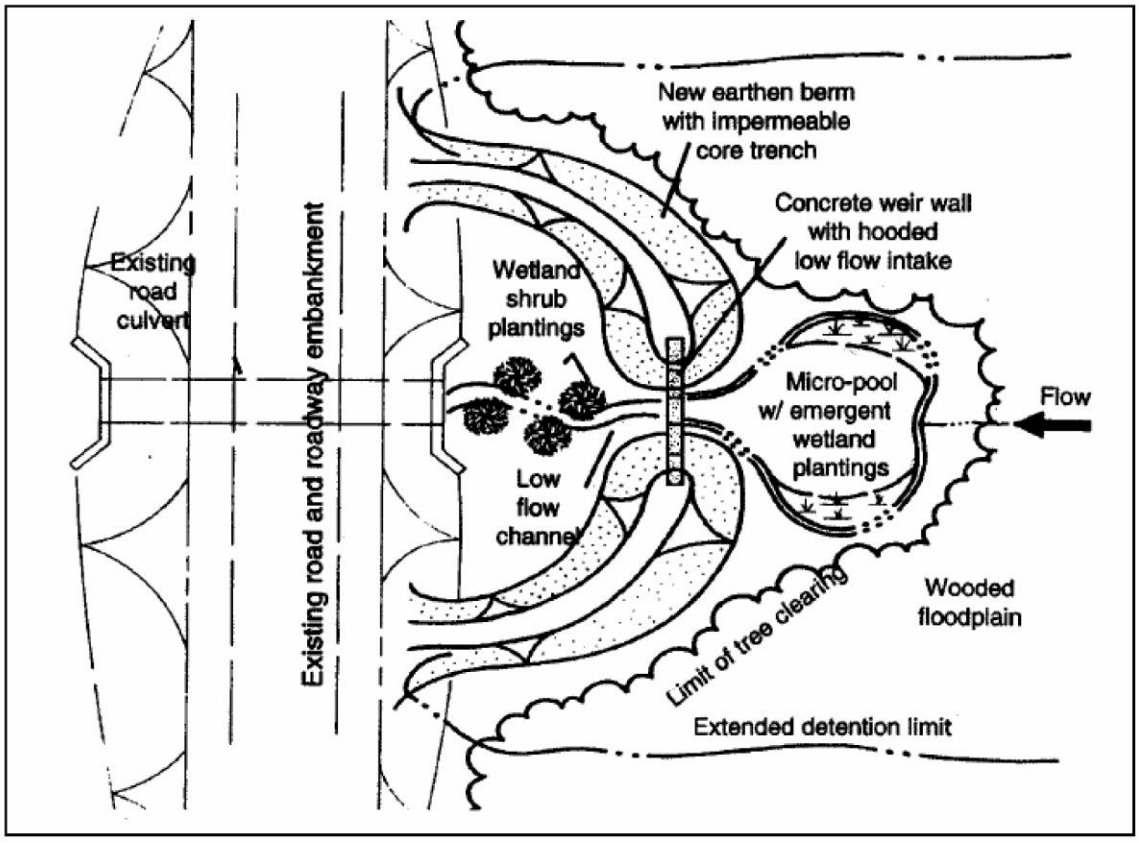


Figure 3-3. Culvert Retrofit (Source: Schueler and Holland 2000)

3.1.4 Bioretention Area ("Rain Garden")

Description: Bioretention is a shallow depression utilized to detain and treat stormwater runoff from small, frequent storms by using a conditioned planting soil bed and planting materials (AMEC 2005). Pollutants are adsorbed by the soil and plant material, improving water quality. Water slowly infiltrates through the soil bed to recharge groundwater or is used by the plants via transpiration. In some cases, an underdrain system can be installed to carry treated water draining through the system to an existing stormdrain network.

Maintenance: Inspect the treatment area's components and repair or replace as necessary. This area is akin to a landscape feature in general maintenance needs, such as removal of accumulated sediment and debris, replacement of dead or stressed plants, and annual mulching (or as necessary). These facilities have an expected life span of 25 years.

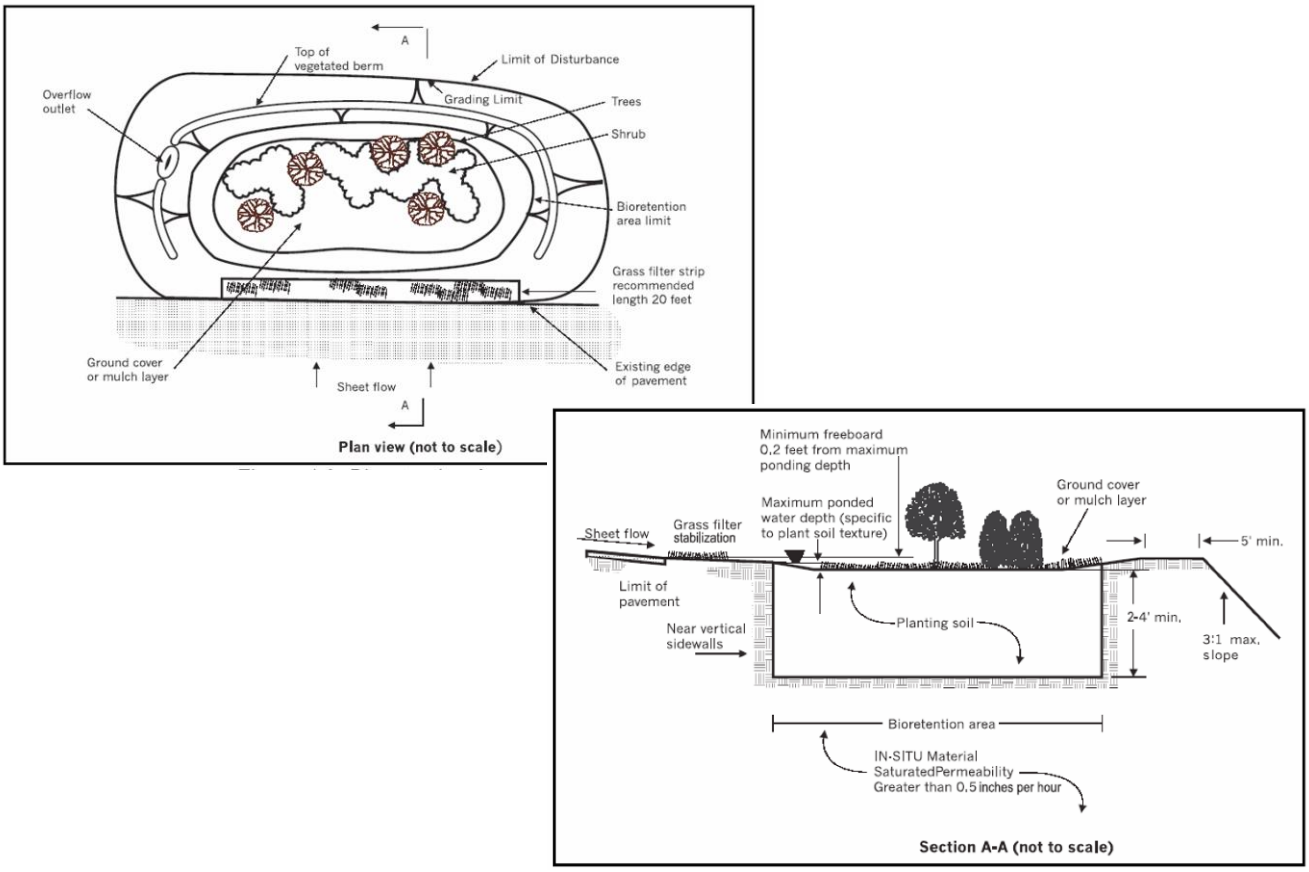


Figure 3-4. Bioretention Area (Source: Prince George's County 1999)

3.1.5 Pipe Outfall Retrofits (Off-Line Bioretention)

Description: This stormwater retrofit option is installed immediately downstream of a stormwater drainage pipe outfall. Flow splitters can be utilized to convey the water quality treatment volume to a sand filter, bioretention area, off-line wetland, or wet pond, while larger storms are allowed to bypass the retrofit (AMEC 2005).

Maintenance: Inspect the treatment area's components and repair or replace as necessary. This area is akin to a landscape feature in general maintenance needs, such as removal of accumulated sediment and debris, replacement of dead or stressed plants, and annual mulching (or as necessary). An observation well can be used to make sure the underdrain is not clogged and is working properly. These facilities have an expected life span of 25 years.

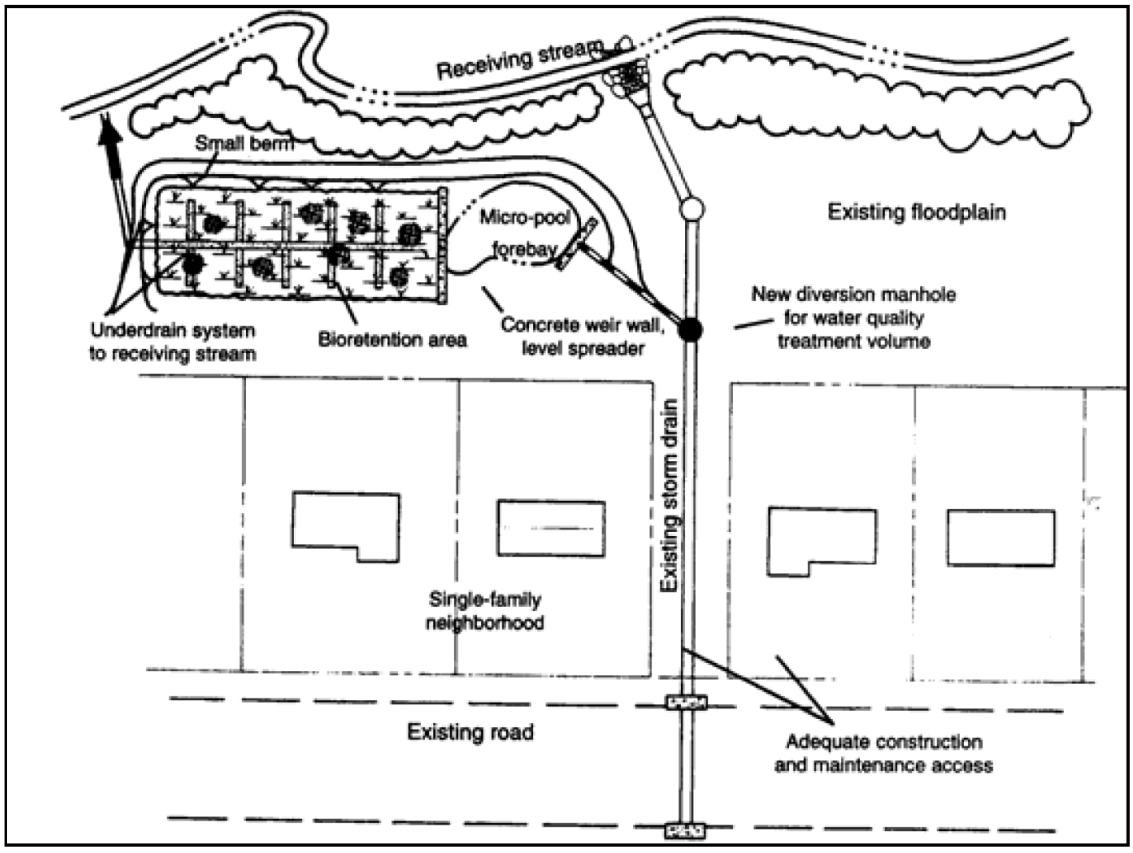


Figure 3-5. Pipe Outfall Retrofit (Source: Schueler and Holland 2000)

3.1.6 Infiltration Trench

Description: An infiltration trench is an excavated trench that has been backfilled with stone to form a subsurface basin. Stormwater runoff is diverted into the trench and is stored until it can be infiltrated into the soil, usually over a period of several days. These structures are ideal for small urban drainage areas and have a longer life cycle when some form of pretreatment to remove sediment, such as a grass swale, is included in the design. Infiltration trenches can be installed in areas adjacent to parking lots, roads, and other impermeable surfaces to capture runoff (AMEC 2005).

Maintenance: Prevent sediments and debris from accumulating on the drained area, which could enter and clog the trench. Sediment and debris removal could be performed by routine sweeping or installation of a grass filter strip or other pretreatment BMP. Maintenance of the pretreatment BMP is very important to prevent clogging. Filter strip maintenance consists of reseeding any eroded areas, and periodically mowing to a height equal or greater than the design flow height. These trenches have an expected life span of 10 years.

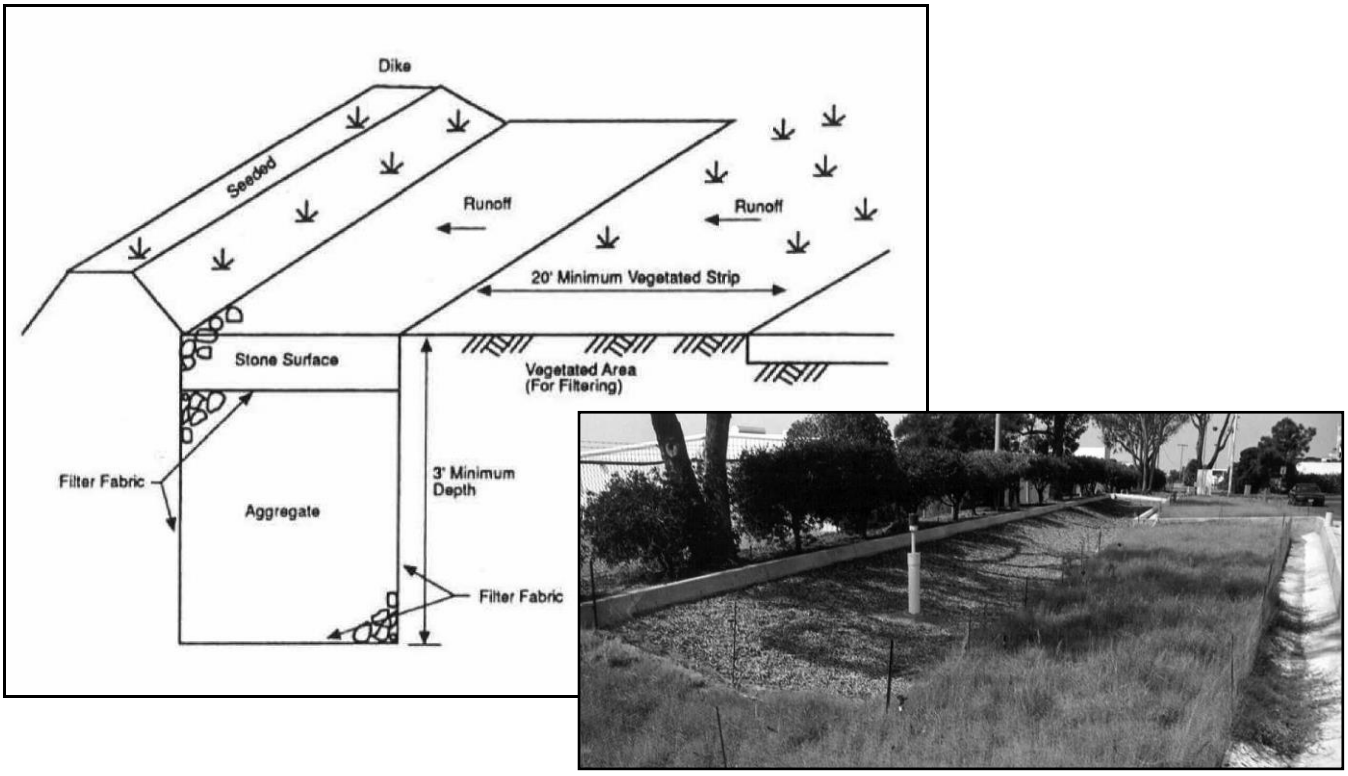


Figure 3-6. Infiltration Trench (Source: American Groundwater Trust and California Stormwater Quality Association in MAPC (Undated))

3.1.7 Grassed Swale

Description: Grassed swales provide both water quantity and quality control. Stormwater travels more slowly in a grass swale than it does in a concrete ditch, reducing runoff volume and downstream erosion (AMEC 2005). Stormwater also infiltrates into the soil, further reducing volume and removing pollutants.

Maintenance: Maintain a dense, healthy grass cover through periodic mowing, keeping grass height at or above the design flow depth. In addition, weeding, watering, reseeding of bare areas, and clearing of debris and blockages may be necessary. Swales should be inspected periodically, especially after significant rain storms to fix problems with sediment buildup and erosion. If sediment buildup occurs, sediments should be removed manually rather than with heavy machinery, which tends to reshape the swale and concentrate erosive flows. Fertilizers and pesticides should be avoided, and only used when the grass cover is diseased or dying. Compaction of the swale, from parking cars and other uses, should also be avoided. Swales have an expected life span of 25 years.

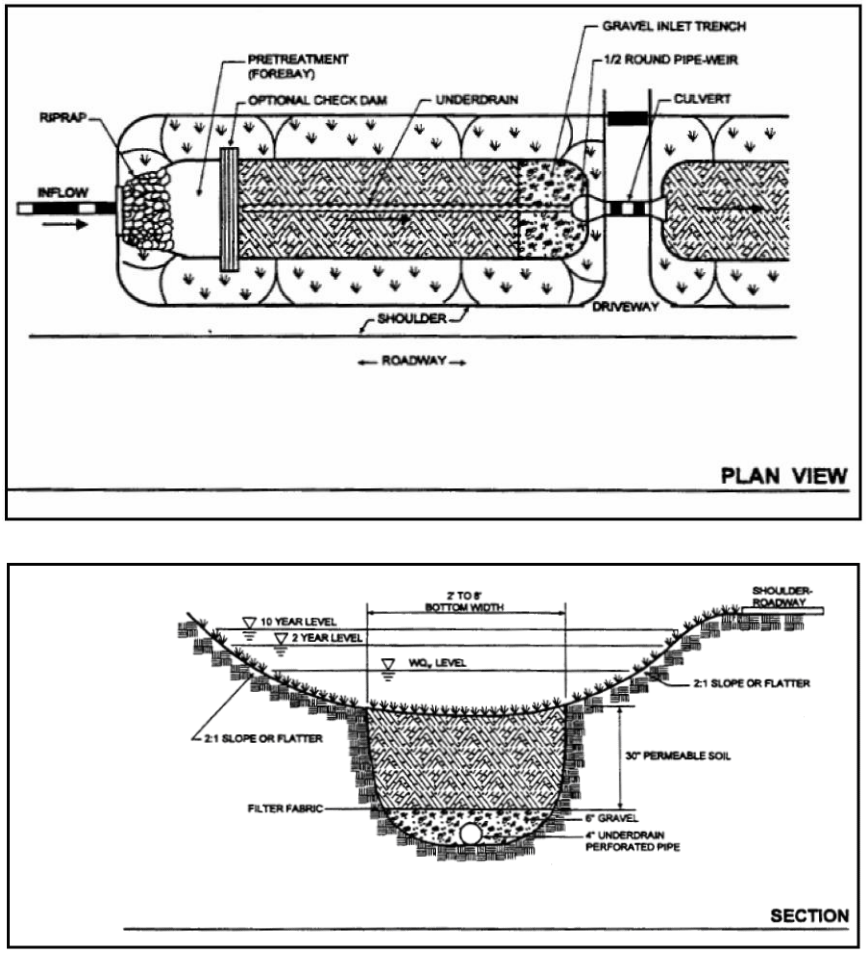


Figure 3-7. Grassed Swale (Source: Prince George's County 1999)

3.1.8 Tree Box Filter

Description: Manufactured LID devices, such as the Filterra® Stormwater Bioretention Filtration System (or a comparable alternative), allow stormwater to flow through a specially designed filter mixture contained in a landscaped concrete container (AMEC 2005). These devices are typically used to retrofit traditional storm drain inlets with a bioretention function. The filter mixture inside the device immobilizes pollutants; those pollutants are then decomposed, volatilized and incorporated into the biomass of the unit. Stormwater runoff flows through the media and into an underdrain system at the bottom of the container, where the treated water is discharged to the stormdrain network.

Maintenance: Debris and sediment removal, replacing dead or stressed plants, and mulching as necessary are the primary maintenance considerations. Most manufactured LID devices come with an observation well that is used to make sure the underdrain is not clogged and is working properly. If the system becomes clogged, the filter mixture is replaced. Additionally, most manufacturers have their own maintenance guidelines that need to be followed to maintain the performance level. Manufactured LID devices have an expected life span of 25 years.

Figure 3-8. Manufactured LID Device – Filterra® tree box insert in storm drain inlet
(Source: VA DCR 2002 and filterra.com)

3.1.9 Rain Barrels/Cisterns

Description: Rain barrels are low-cost, effective and easily maintainable retention devices that can be used in both residential and commercial/industrial sites. They are connected to down-spouts and retain rooftop runoff. Rain barrels can be used to store runoff for later use in lawn and garden watering (AMEC 2005). Cisterns are larger rainwater storage containers placed either above or below ground used for watering and other non-potable uses.

Maintenance: Rain barrels and cisterns require very little maintenance. The container and attachments should be inspected for clogging several times a year and after significant storm events. Minor parts, including spigots, screens, filters, downspouts, or leaders, may require replacement. Rain barrels and cisterns have an expected life span of 25 years.

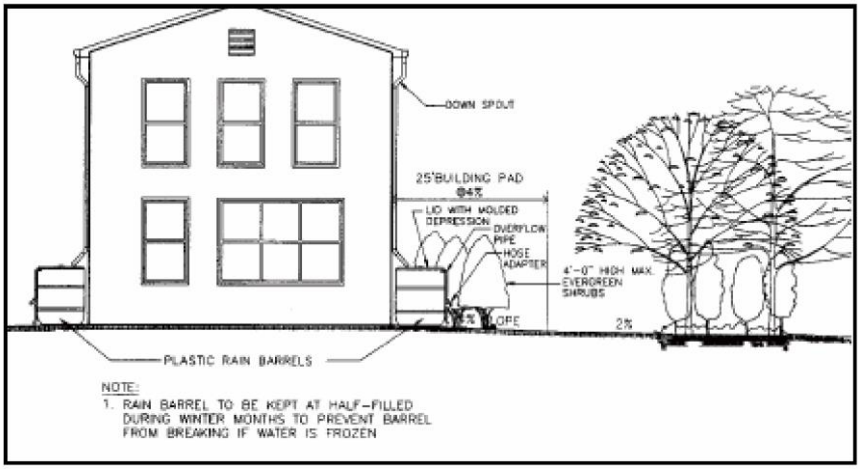


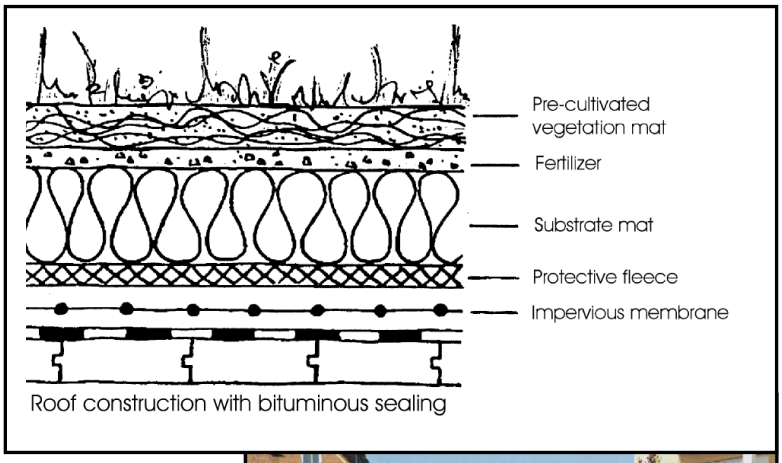
Figure 3-9. Rain barrel & above-ground cistern
(Sources: Prince George's County 1999; www.aridsolutions.com; and www.plastmo.com)

3.1.10 Green Roof Carport

Description: Green roof technology, consisting of a layer of soil and vegetation on top of an impervious rooftop, can be applied to carports to provide a number of benefits.

Economic Benefits –

- Increase in life expectancy of rooftop and waterproofing (2-5 times) by providing protection against temperature extremes and ultra-violet light, thereby off-setting somewhat higher up-front installation costs
- Conversion of carports to green roofs is substantially less expensive than for buildings, yet provides equal benefit per square foot of impervious surface.



Ecological Benefits –

- Reduce stormwater runoff (30-100% of annual rainfall can be stored, relieving stormdrains and feeder streams)
- Reduce heat island effect (cooler air temperatures and higher humidity can be achieved through natural evaporation)
- Improve Air Quality (up to 85% of dust particles can be filtered out of the air)
- New habitat for plants, insects, and birds

Figure 3-10. Carport with green roof
(Source: Prince George's County 1999)

Amenities –

- Overhead cover provides shade to reduce interior car temperatures during hot weather, reduces need to clear snow from parked cars, and provides shelter while entering/exiting the car during inclement weather
- Reduction of noise level due to less sound reverberation and improved sound insulation
- Visible green roofs provide a more aesthetic landscape

Maintenance: Once a green roof is well established, its maintenance requirements are usually minimal. Initial watering and occasional fertilization are required until the plants have fully established themselves, and periodically thereafter during drought conditions. Periodic trimming, weeding, inspection, and plant replacement is necessary.

3.1.11 Stream Restoration/Bank Stabilization

Description: Streams damaged by erosive flows, excess sedimentation, and disruptive human activities are often not capable of re-establishing a stable form. Techniques to repair these damaged or degraded streams are now based on mimicking natural stream channels and the range of natural variability exhibited by nearby stable streams. Termed natural stream channel design, repairs focus on establishing natural stream channel shape, size, and habitat features. Restoration can range from minor repairs to restore bank stability to complete stream channel reconstruction.

Maintenance: Maintenance of natural stream channel design projects includes periodic inspection and monitoring to ensure that conditions remain within the expected range of variability. Post-construction plantings need to be monitored to ensure that they become well-established. In addition, periodic channel adjustments may be necessary after large flow events, especially while post-construction plantings become established.

A.

B.

Figure 3-11. Stream Restoration (A. concrete lined urban channel; B. restored stream)
(Sources: M. Perot; unknown)

3.1.12 Riparian Buffer/Vegetation Enhancement

Description: Trees, shrubs, flowers, grasses, and other vegetation reduce runoff volume through evapotranspiration and interception by leaves and improve the infiltration capacity of the soil, thereby reducing runoff potential (Brooks et al. 1991). Native varieties of trees, shrubs, and wildflowers are placed strategically, as site conditions warrant, as a streamside (riparian) buffer, in flow paths and depressions, or in unused open space to adsorb runoff and facilitate infiltration (Tjaden and Weber 1999; Philadelphia Water Department 2006). Vegetation filters sediment and other pollutants from stormwater runoff, moderates surrounding air temperatures and humidity, moderates water temperatures in streams, improves aesthetics, and provides shelter and food to both terrestrial and stream organisms.

Maintenance: Maintenance of vegetation enhancement projects includes periodic watering, removal of invasive species through selective mechanical or chemical treatments, and trash clean-up to ensure that plantings become well-established. Replanting trees, shrubs and wildflowers in unused open spaces also reduces lawn maintenance costs associated with these areas. For example, a study in Maryland by Howard County Parks and Recreation Department comparing maintenance costs of meadows versus turf grass along highway right-of-ways found that wildflower meadows were twenty times less expensive to maintain than conventional turf grass (USEPA 1993).

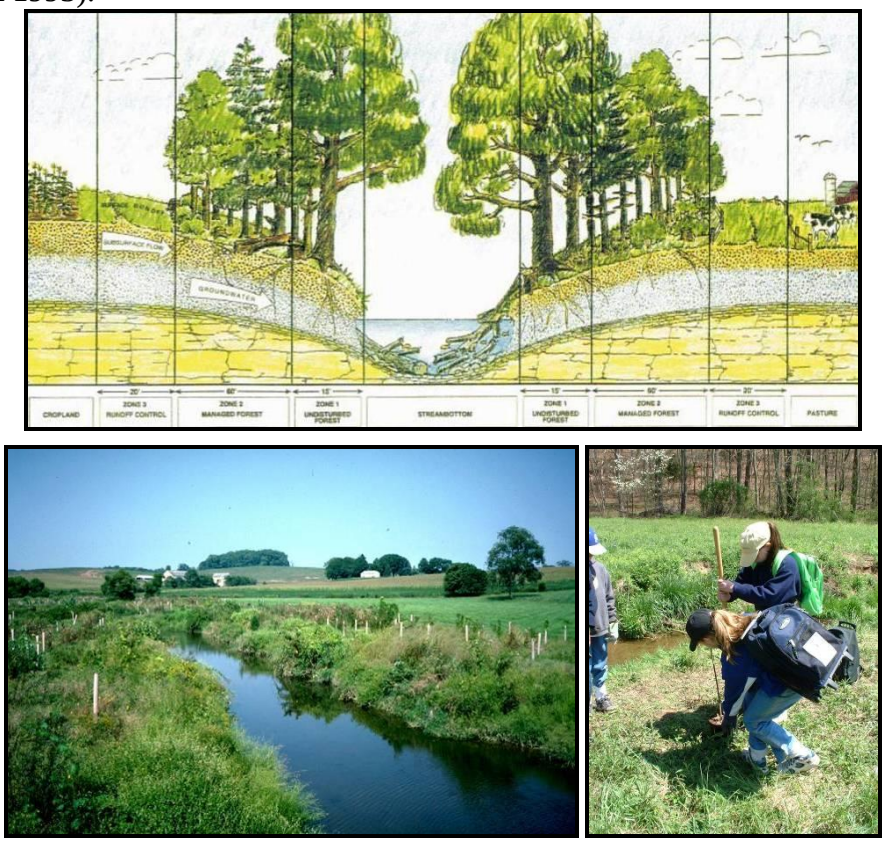


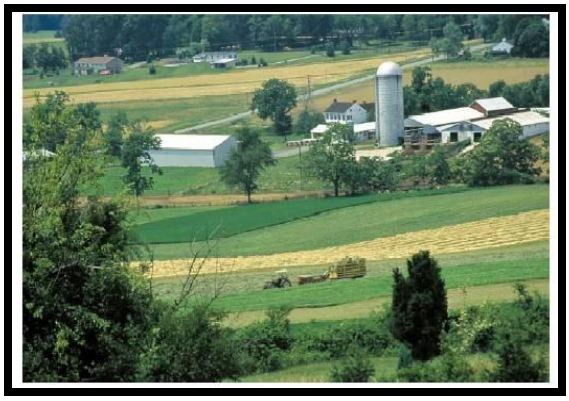
Figure 3-12. Buffer enhancement
(Sources: Palone and Todd 1998; MDE 2000b; M. Southerland)

3.1.13 Agricultural BMPs

Description: A wide range of soil and water conservation, water quality, nutrient management, herd health, and agricultural preservation practices have been developed for use in agricultural settings. The following are some examples of agricultural BMPs (modified from Marinette County 2005). Additionally, there are many sources of educational, technical assistance, and funding support available to facilitate water quality and watershed protection resources.

High Residue Management
This practice leaves at least 30% of the ground covered with crop residue (leaves and stalks) after crops are planted. Crop residue limits erosion by protecting and binding the soil.

Cropland Protection Cover
A crop of close growing grasses, legumes, or small grains grown to control erosion during periods when the major crops do not furnish adequate protection. It is usually grown for one year or less.



Contour Planting
Crop rows are planted across the slope of the land to divert water from areas where it may cause flooding or erosion and to promote infiltration. Row crops are alternated with standing crops in a rotational program.

Field Diversions
A shallow channel constructed across the slope of the land to divert water from areas where it may cause flooding or erosion and to promote infiltration. The water is diverted to where it can be stored or transported safely.

Grassed Waterways
A natural or constructed channel shaped, graded, and established with suitable cover to prevent erosion by runoff waters.

Streambank Fencing
Excludes livestock from the near shore area to prevent trampling, grazing, livestock injury, and protect riparian habitat.

Remote Watering System
Development of a system of portable tanks, pumps, and pipes designed to bring water to livestock in grazing cells.
(Photo courtesy of USDA-NRCS)

Barnyard Runoff Management
Structural measures to redirect surface runoff around the barnyard, and collect, convey or temporarily store runoff from the barnyard. Management measures include: sediment basins, roof gutters, and clean water diversions.

Animal Lot Relocation
Relocation of an animal lot from a critical site, such a floodway, to a suitable site to minimize the amount of pollutants from the lot to surface or groundwater.

Easements
Easements are legally binding restrictions on land titles purchased to provide permanent vegetative cover.

3.2 COSTING

We have also included rough cost estimates that may be used for planning purposes. Cost information was gathered from a number of sources and have been adjusted to include: engineering, design, and permitting (30%); mobilization of equipment (5%); and contingency (30%). Note that costs may vary depending on location, accessibility, whether or not land or easement purchase is required, and other site-specific factors. Costs for land acquisition or easements were not included in our estimates as we understand the County intends to primarily target projects on land already within County ownership or easements, and Community Restoration partners would likely work collaboratively with private land owners. The estimates below are intended for general planning purposes only. These general planning costs represent actual costs that in many cases can be off-set or eliminated through the use of existing staff resources, in-kind services, cost-share programs, donated materials, use of volunteers, and other avenues.

Several sources were used to develop unit cost estimates for the proposed stormwater retrofit, stream restoration, and agricultural BMP elements used in this study. These unit cost estimates were based upon a number of assumptions outlined in Table 3-1 and cost information found in RSMeans Building Construction Cost Data (2005), RSMeans Environmental Remediation Cost Data – Assemblies (2003), and A User's Guide to Watershed Planning in Maryland prepared by the Center for Watershed Protection (CWP 2005). Additional information on these costs is discussed below and presented in Appendix D.

Site specific cost estimates for the Tier 1 sites were developed by applying site-specific quantities based upon the anticipated size of the proposed LID structures (as listed in the project fact sheets in Section 4.1). Costs for the LID structures at the Tier 2 and CR sites were generated using standardized sizes for off-line bioretention structures (1,500 sq. ft.), rain gardens (1,000 sq. ft.), SWM pond retrofit (1,000 sq. ft.), and site specific lengths and areas.

Aerial photos were used to approximate the following dimensions:

- Linear Feet (LF) for Bank Stabilization, Detention Berms, Grass Swales, Infiltration Trenches, Riparian Buffer, Streambank Fencing, and Stream Restoration
- Square Feet (SF) for Off-Line Bioretention, Linear Rain Gardens, Rain Gardens, and SWM Pond Retrofits
- Acres (AC) for Reforestation, Buffer Planting, and Wildflower Planting

Table 3-1. Watershed restoration practice types, unit costs, and source of costing information

Practice Type	Description	Unit Cost	Units	Costing Source
Alternate Livestock Watering	gravity powered system	$9,555	EA	Lynch and Tjaden 2000
Bank Stabilization	bioengineering stabilization methods	$177	LF	Perot et al. 2005, Keystone Stream Team 2005
Barnyard Runoff Controls	animal waste management system	$9,828	EA	CWP 2005
Buffer Planting - Urban	soil amendments, rubble removal, invasive plant removal, container trees	$7,542	AC	CWP 2005
Dedicated Stream Crossing	crossing constructed with stone	$8,190	EA	Lynch and Tjaden 2000
Detention Berm	height of berm - 0.5 feet; width of berm - 1.5 feet; vegetative cover	$4	LF	RSMeans 2003, 2005
Grass Swale	10-foot-wide swale	$11	LF	RSMeans 2003, 2005
Infiltration Trench	depth of trench - 4 feet; width of trench - 3 feet; geotextile liner; crushed stone; vegetative cover	$177	LF	RSMeans 2003, 2005
Linear Rain Garden	depth of excavation - 4.5 feet; backfill, grading and compaction; planting soil and mulch; drainage swale; trees and shrubs	$18	SF	RSMeans 2003, 2005
Off-line Bioretention	depth of excavation - 4.5 feet; backfill, grading and compaction; planting soil and mulch; piping and low flow outlet; plantings	$21	SF	RSMeans 2003, 2005
Rain Barrels	two barrels per dwelling	$562	Dwelling	LID Center, Inc. undated
Rain Gardens	depth of excavation - 4.5 feet; backfill, grading and compaction; planting soil and mulch; drainage swale; trees and shrubs	$18	SF	RSMeans 2003, 2005
Reforestation	soil amendments, rubble removal, invasive plant removal, container trees	$7,542	AC	CWP 2005
Riparian Buffer - Rural	50-foot wide, forested buffer, both sides of stream; including soil amendments, rubble removal, invasive plant removal, container trees	$3	LF	CWP 2005
Road Demolition	asphalt road, width of excavation - 14 feet, depth of excavation - 2 feet	$100,000	AC	RSMeans 2003, 2005
Stream Restoration	Channel modifications using Natural Stream Channel Design principles and in-stream structures	$390	LF	Perot et al. 2005, Keystone Stream Team 2005
Streambank Fencing	High tensile, 3-strand electric fence	$4	LF	Lynch and Tjaden 2000

Table 3-1. (Continued)

Practice Type	Description	Unit Cost	Units	Costing Source
SWM Pond Retrofit	wet pond excavation depth - 3 feet; clear and grub; backfill, grading and compaction; stone gabions; vegetative cover; wetland vegetation; clay liner; geotextile liner; rip-rap liner; riser outlet	$27	SF	RSMeans 2003, 2005
Tree box filters	pre-cast concrete, 6' x 6'manufactured tree box filter to treat ¼ acre impervious surface, installation	$13,309	EA	LID Center, Inc. undated
Wildflower Plantings	fertilize and seed	$5,324	AC	RSMeans 2003, 2005

It is worth noting that rain garden construction costs can be extremely variable. For example, construction of rain gardens at commercial, industrial, and institutional sites, which may need flow control structures, curbing, storm drains, and underdrains, can cost about ten times more per square foot than residential rain gardens (Coffman et al. 1999). In any rain garden design, the cost of plants varies substantially and can account for a significant portion of the facility's expenditures (Coffman et al. 1999). However, landscaping and maintenance costs would be incurred for these spaces in any case. The typical rain garden design does not include an underdrain system that would tie into the existing storm sewer lines at the sites. The cost of an underdrain system can range from $10,000 to $50,000 (RSMeans 2005, RSMeans 2003) depending upon size and the length of piping necessary to reach the storm sewer line.

Because many LID approaches are designed to be integrated into a site design and typically have a multiple-use aspect, implementation costs may be reduced or off-set by existing facility maintenance or improvement programs. For example, landscaping is an on-going expense at many public and private facilities, and this spending typically includes mulching, weeding, seasonal replacement of stressed or annual plantings, pruning, and lawn mowing. Maintenance of bioretention areas and other LID practices have the same requirements, so LID maintenance would not necessarily be a new expense for the facility. In addition, introducing LID techniques during normal maintenance/upgrade cycles will reduce both LID implementation costs and regular maintenance spending by sharing expenses between programs.

Cost estimates for retrofitting existing stormwater management ponds vary widely depending on the nature of the designed improvements. Typically, improvements are necessary to the control structure and outlets to reduce discharge rates, as well as introduction of features to improve water quality. These design and modification costs vary widely and are dependent upon site specific factors.

Costs for stream restoration projects are based on "Guidelines for Developing Cost Ranges of a Natural Stream Channel Design Project" recently reported by the Keystone Stream Team (2005) for projects in Pennsylvania, and used in Ballenger Creek (Perot et al. 2005). These

Guidelines provide up-to-date cost range examples, in settings similar to Frederick County. Stream restoration costs include a riparian buffer component, and costs for these projects are based on unit cost developed for similar projects in the Ballenger Creek study. These cost estimates do not include: natural diversity or archaeological surveys, land development plans, zoning variances or waivers, changing FEMA maps, or wetland mitigation.

In most cases, only limited, visual inspection data are available for the candidate sites. Projects at all sites, and the stream restoration sites in particular, will need additional study to gather data necessary for engineering design and are likely to require permits prior to construction. Until engineering studies are completed, it is only possible to determine the extent of stream channel re-construction in approximate terms. Significant geomorphologic measurement, in-depth analysis of land cover change, modeling of resulting impacts on flow and sediment transport regimes, and extensive GIS and computer-aided design (CAD) design work are required to determine the magnitude of work required at a particular site.

Cost estimates for other BMPs in agricultural areas, namely riparian buffer enhancement, streambank fencing, dedicated stream crossings, and barnyard runoff management, were obtained from Lynch and Tjaden (2000) and CWP (2005). Specifically, costs for riparian buffers were based on creating a 50-foot wide, forested buffer on both sides of the stream, and costs for streambank fencing included 3-strand, electric fence on both sides of the stream (Table 3-1).

In many cases, costs for agricultural BMPs, including riparian buffers, livestock exclusions from streams, alternate watering sources, stream crossings, etc., may be substantially off-set through programs offered by the US Department of Agriculture's Natural Resource Conservation Service (NRCS), the Maryland Department of Agriculture, and the Frederick County Soil Conservation District.

3.3 UTILITIES

Although underground and overhead utilities may be present at many of the candidate project sites, frequently they are only a minor site constraint that can be worked around by adjusting designs accordingly. We have identified known utilities that were observed at the Tier 1 sites during field visits, and water and sewer line locations shown in GIS files provided by the County. These are noted on the individual project Fact Sheets in Section 4.1.

Once candidate sites have been selected for subsequent feasibility and design phases, a thorough review of utilities should be undertaken to identify upgrades to known utilities or those not identified in this preliminary review. In addition, prior to any surface disturbance work, a utility locator service should be contacted to mark actual locations. The following utility contacts are presented to facilitate future utility inquiries (Table 3-2).

Table 3-2. Utility contacts for potential project sites in Linganore Creek watershed (as of April 2006)		
Utility	**Contact**	**Phone**
Adelphia Cable	Noel Rice	301-662-6822 ext. 1212
Allegheny Power	Edgar Martinez Lines Engineering Designer	301-694-4486
Frederick County Division of Utilities and Solid Waste Management	Dianna Lu	301-631-3509
Verizon	Dennis Schaeffer Engineer 33 East Patrick St. Frederick, MD 21701	301-694-5646
Verizon Construction	Ted McCrobie	301-682-9382
Washington Gas	Orrin Spence	301-644-2377
MISS UTILITY	www.missutility.net	800-257-7777

4.0 SITE-SPECIFIC OPPORTUNITIES

Candidate watershed restoration projects were identified at 167 sites, representing four different restoration approaches (Table 4-1, Figure 4-1). Once land ownership and other requirements were considered, the 167 sites were divided into two groups: 37 CIP projects and 130 Community Restoration projects. Ranking scores for CIP projects were used to designate 15 sites as Tier 1 and 22 sites as Tier 2. County ownership for the candidate CIP sites is summarized in Table 4-2.

Table 4-1. Summary of candidate restoration projects, by project type

	CIP Tier 1	CIP Tier 2	Community Restoration	Total
Agricultural Program			85	85
Low Impact Development	11	22	31	65
Stream Restoration	1		9	9
SWM Pond Retrofit	3		5	8
Total:	15	22	130	167

Table 4-2. Summary of ownership for the candidate CIP project sites

Ownership	Tier 1	Tier 2	Total
Frederick County Board of Education	6	2	8
Frederick County Department of Highways and Transportation	6	19	25
Frederick County Department of Parks and Recreation	2	0	2
Frederick County Division of Public Works	0	1	1
Frederick County Division of Fire & Rescue Services	1	0	1
Total:	15	22	37

All sites were mapped and superimposed upon the County's aerial photography from March 2000; the watershed has been mapped in three sections (West, Northeast, and Southeast) to provide a readable scale (Figures 4-2, 4-3, and 4-4). Details on individual sites are provided in the following report sections.

Based on the prioritization process employed in this study, the Tier 1 candidate sites represent the greatest opportunity for project implementation via the County's CIP, either as individual or grouped projects. In Section 4.1, detailed conceptual plans/Fact Sheets for Tier 1 sites describe the nature of the problem and recommended approaches for addressing these opportunities. Opportunities at the remaining Tier 2 sites, as well as the CR sites, have been briefly described in Sections 4.2 and 4.3 to provide information should the chance to initiate additional opportunities arise. Although the rankings for these sites are based on a number of important factors, we anticipate that the County will ultimately choose a suite of final

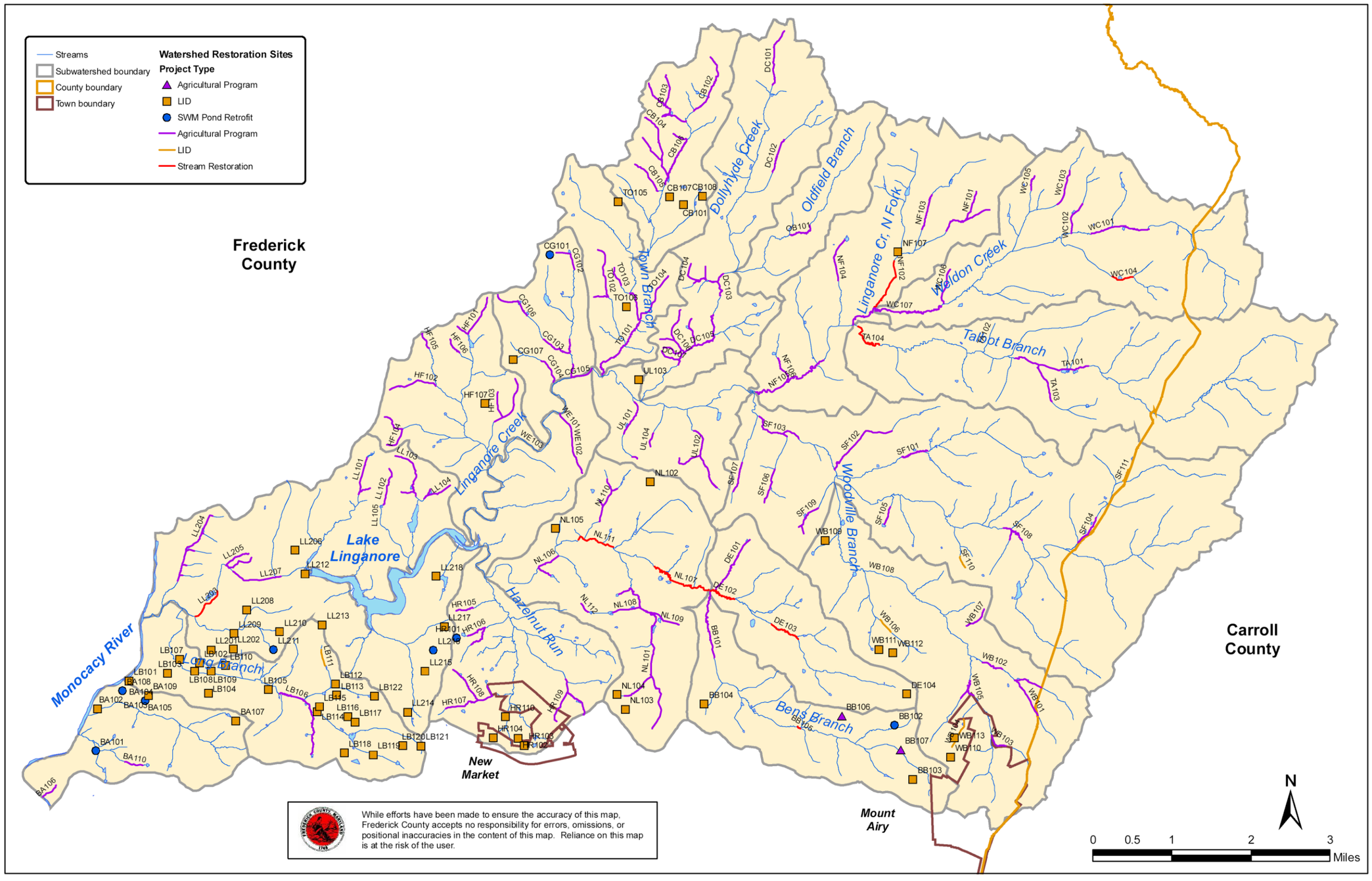


Figure 4-1. Location and project type of candidate watershed restoration projects in Linganore Creek Watershed

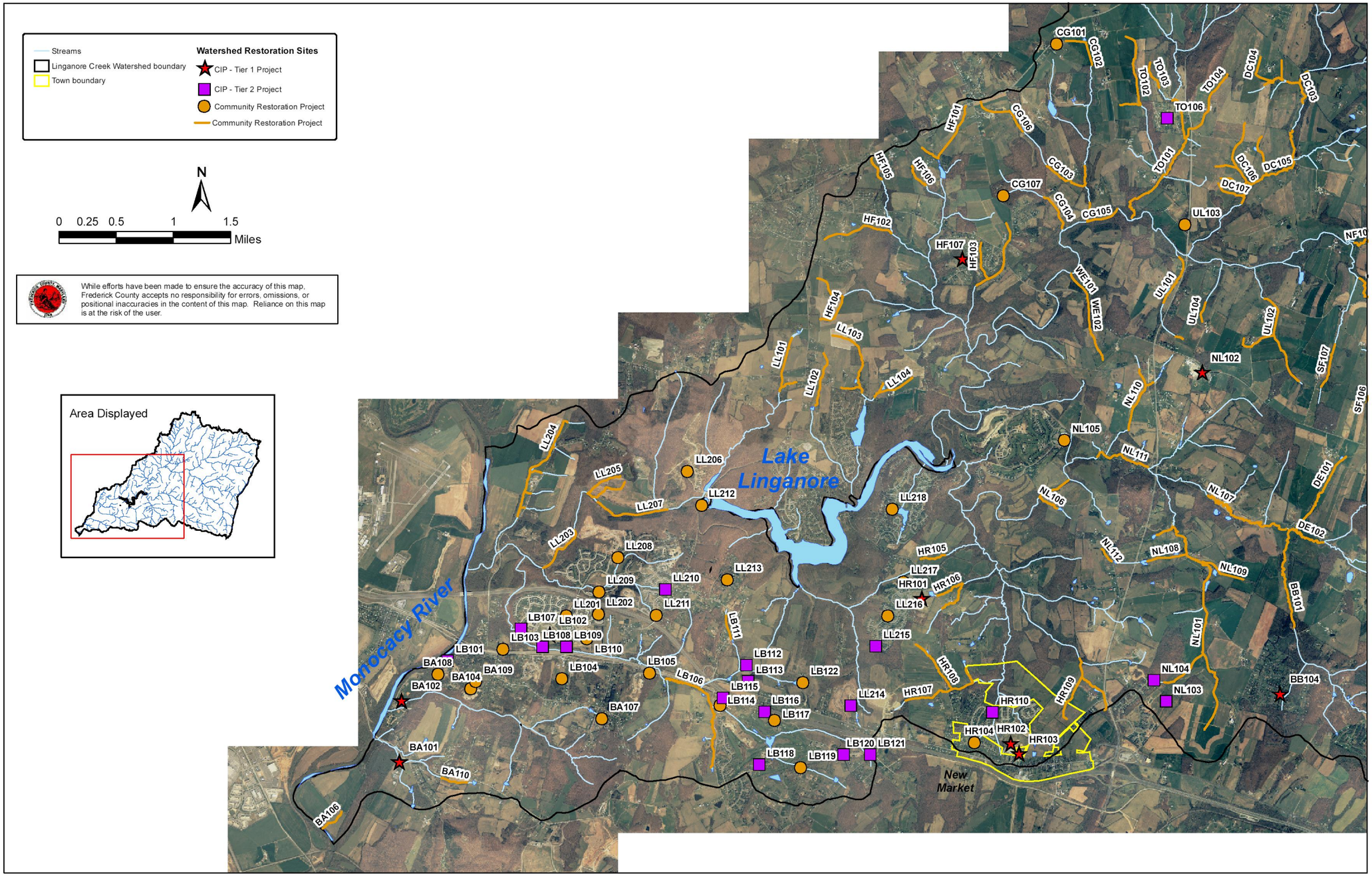


Figure 4-2. Candidate watershed restoration sites identified in the western portion of Linganore Creek Watershed, Frederick County, MD

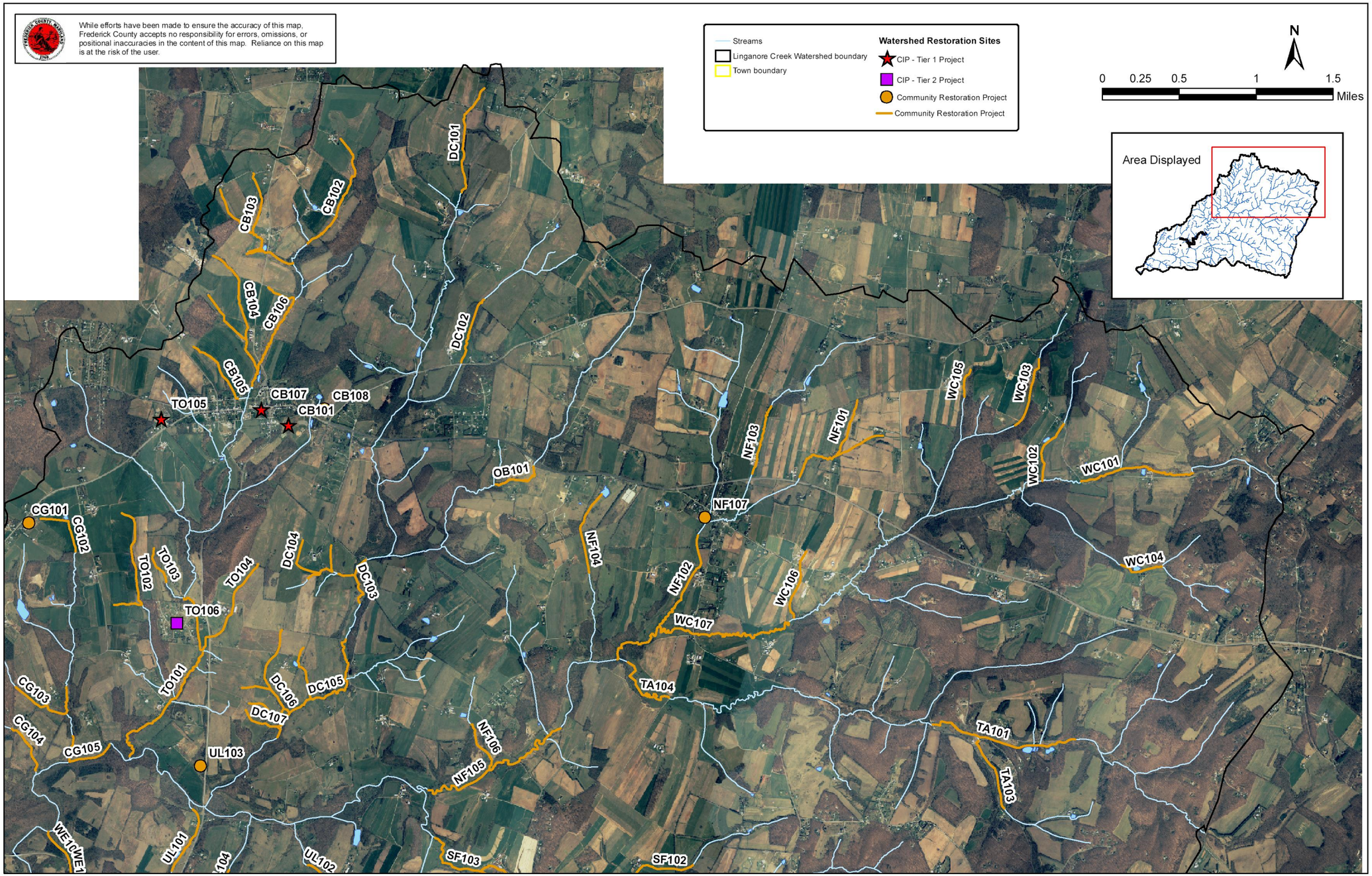


Figure 4-3. Candidate watershed restoration sites identified in the northeastern portion of Linganore Creek Watershed, Frederick County, MD

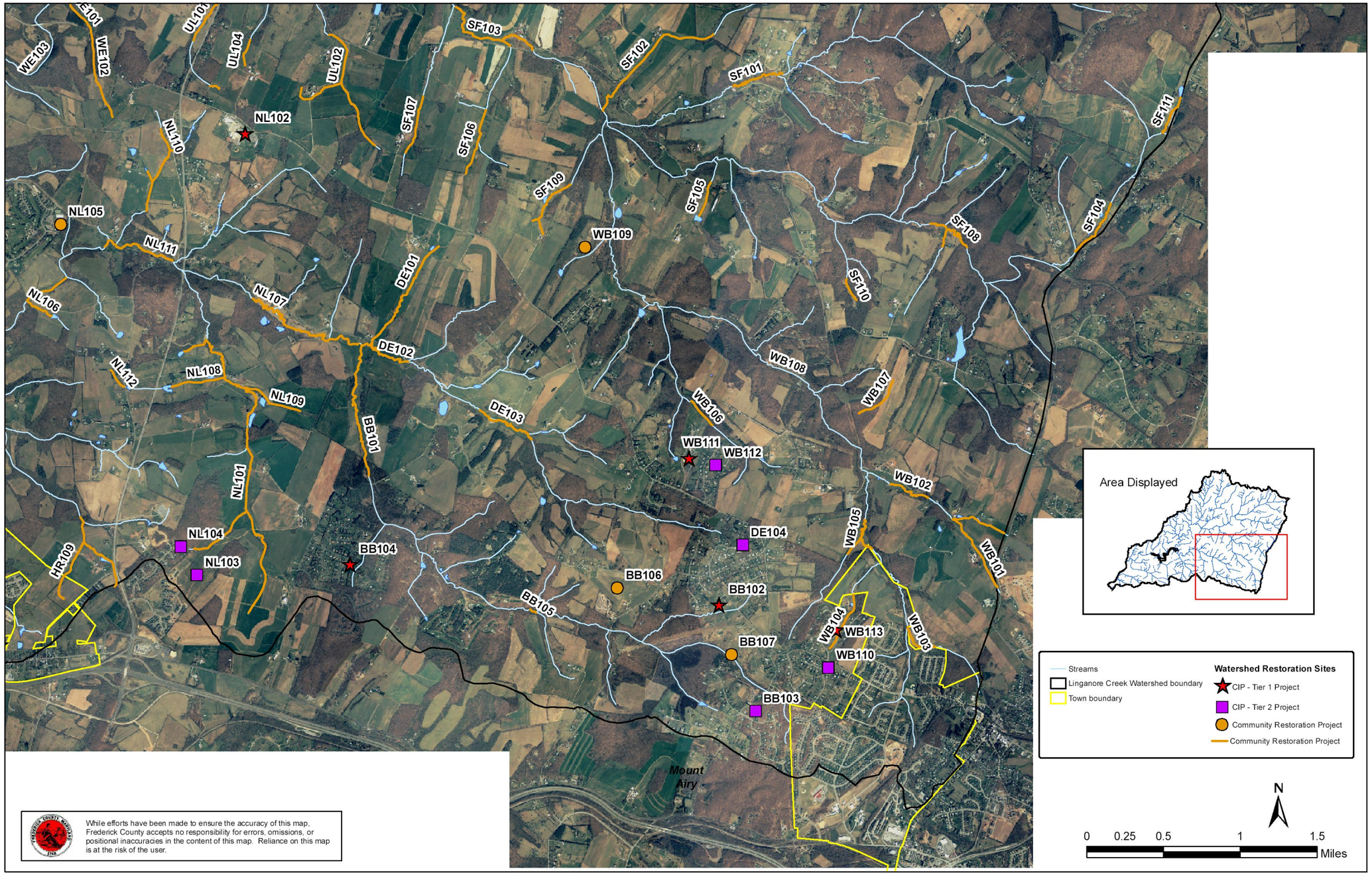


Figure 4-4. Candidate watershed restoration sites identified in the southeastern portion of Linganore Creek Watershed, Frederick County, MD

sites based on integrating these results with other information, including data not currently available. In addition, some of these projects may be implemented by other organizations.

It should also be noted that substantial opportunities to provide additional SWM controls and improve stream stability identified in this study are located on property not owned by the County. Identified as Community Restoration sites, these opportunities represent a wide range of activities, from enhancing streamside buffers in both agricultural and residential areas, to implementation of neighborhood LID projects, and would benefit from some form of County support to facilitate their implementation.

4.1 TIER 1 CANDIDATE SITES

Table 4-3 lists the 15 CIP Tier 1 sites with site information and prioritization scores. The following pages present a series of project Fact Sheets for each of the 15 Tier 1 sites, described in numerical order, by site number. These sites present the best opportunities for the County to implement via its CIP.

The maps presented on these project fact sheets indicate potential locations for various project elements at each site. Project element locations and practice types were identified during the site visits based on site drainage pathways, land use, available space, and other observed site constraints. Approximate drainage areas, representing the estimated area treated by the listed practices, are also included on the fact sheets. These drainage area estimates are based on visual observations of site-scale topography and drainage pathways during the field visits, and accuracy of these estimates is roughly on the order of ± 10 percent.

Table 4-3. Summary and ranking of candidate CIP watershed restoration opportunities in Linganore Creek. These sites (CIP Tier 1) represent the best opportunity for watershed improvements.

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Estimated Project Cost	Total Score
CIP Tier 1								
NL102	New London	LID	Linganore High School	Old Annapolis Road	Public - County owned	Install linear rain gardens along Old Annapolis Road, in parking lots, and next to athletic fields; place rain gardens around parking lots; provide off-line bioretention at two outfalls; place detention micro-berms across drainage pathways; and plant wildflowers and trees in unused open space.	$1,352,000	75
TO105	Town Branch	LID	Liberty Elementary School	Liberty Road	Public - County owned	Install linear and area rain gardens in traffic islands and landscape beds around school; build off-line bioretention garden below culvert outfall; place detention micro-berm along field margins; and provide linear rain gardens next to athletic fields.	$310,000	72
BA102	Bartonsville	Stream Restoration & LID	Pinecliff Park	Pinecliff Park Road	Public - County owned	Stabilize approximately 1,000 ft. of streambank; construct linear rain gardens along parking lot and road margins; place rain gardens in three parking lots; add detention micro-berm along stream and woods; buffer enhancement along Monocacy River; plant wildflowers on sledding hill (mow before sledding season); and plant wildflowers on top of sewer and water lines, and in unused open spaces.	$473,000	69
WB113	Woodville Branch	LID	New Estates Subdivision - LID 2	Cindy Court and North Annapolis Drive	Public - County ROW/Easement	Retrofit existing roadside swales with linear rain gardens throughout the subdivision.	$515,000	69
BA101	Bartonsville	SWM Pond Retrofit	Frederick County Public Safety Training Facility	Reichs Ford Road	Public - County owned	Upgrade control structure for Structure No. 123 (extended detention wet pond) to MD2000 standards and add sediment forebay to pond; place culvert retrofits at two roads; build detention berms and linear rain gardens near training areas; add infiltration trench to parking lot; plant wildflower and forested buffer around pond and along stream; and reforest unused open space on hillside.	$400,000	67
LB102	Long Branch	LID	Spring Ridge Elementary School	Ridgefield Drive	Public - County owned	Install rain gardens, infiltration trenches, and tree box filters in drive and parking areas; place a detention micro-berm along edge of playing fields; add linear rain gardens in roadside swales; build rain gardens in the northwest and southwest lawns; and plant unused open space with trees and wildflowers.	$792,000	66
WB111	Woodville Branch	LID	Willow Pond Estates - LID 2	Amys Terrace	Public - County ROW/Easement	Retrofit existing roadside swales with linear rain gardens throughout the subdivision.	$397,000	66

Table 4-3. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Estimated Project Cost	Total Score
CIP Tier 1								
CB107	Coppermine Branch	LID	North Street - LID	North Street at Coppermine Branch through Libertytown	Public - County ROW/Easement	Work within County road rights-of-way to install linear rain gardens in roadside swales along North Street and creation of a wildflower buffer along roadside stream. In addition, support LID assistance programs on private property (e.g., Backyard buffer program, rain barrel coupon program, technical assistance for rain gardens).	$162,000	66
HF107	Horseshoe Farms	LID	Horseshoe Farms Estates - LID	Equestrian Way, Bridle Path, and Old Annapolis Road	Public - County ROW/Easement	Retrofit existing roadside swales with linear rain gardens throughout the subdivision. Provide outreach and technical assistance to homeowners for rain barrels and rain gardens on private property.	$1,721,000	65
CB101	Coppermine Branch	LID	Libertytown Community Park - LID	MD 26	Public - County owned	Retrofit park facilities by installing linear rain gardens along the entrance drive, and in swales at the east and west sides of the parking lot; build rain gardens for tennis and basketball courts, and the southeast corner of the athletic field; add a detention micro-berm along the stream; and plant wildflowers and trees in unused open spaces.	$288,000	63
BB102	Bens Branch	SWM Pond Retrofit	FCDPW Jacobs Run SWM Facility	Jacobs Court	Public - County owned	Retrofit oil and grit separator with an off-line bioretention facility below the outfall; install linear rain gardens in grass swales along edges of Jacobs Court.	$65,000	63
HR101	Hazelnut Run	SWM Pond Retrofit	Deer Crossing Elementary School	Boyers Mill Road	Public - County owned	Upgrade control structure for Structure No. 600 (extended detention pond) to MD2000 standards; reforest unused grass areas; install linear bioretention along Finn Drive and school entrance; place rain gardens near basketball court and baseball field; and create a detention micro-berm along the southeast margin of playing fields.	$753,000	61
BB104	Bens Branch	LID	Catoctin View Subdivision - LID	Catoctin View Drive	Public - County ROW/Easement	Retrofit existing roadside swales with linear rain gardens throughout the subdivision.	$931,000	61
HR102	Hazelnut Run	LID	New Market Middle School	Main St.	Public - County owned	Retrofit control structure of dry detention pond to MD2000 standards, incorporating multi-cell bioretention areas in the pond bottom; build rain gardens in lawn areas, around building, and next to paved areas; install infiltration trench in parking lot; add detention micro-berms in lawn areas; and reforest unused open space.	$576,000	60
HR103	Hazelnut Run	LID	New Market Elementary School	Main St.	Public - County owned	Construct rain gardens in lawn areas, around building, and next to paved areas; install infiltration trench in parking lot; build off-line bioretention garden at outfall; and build a detention micro-berm in the lawn area along east property line.	$157,000	60

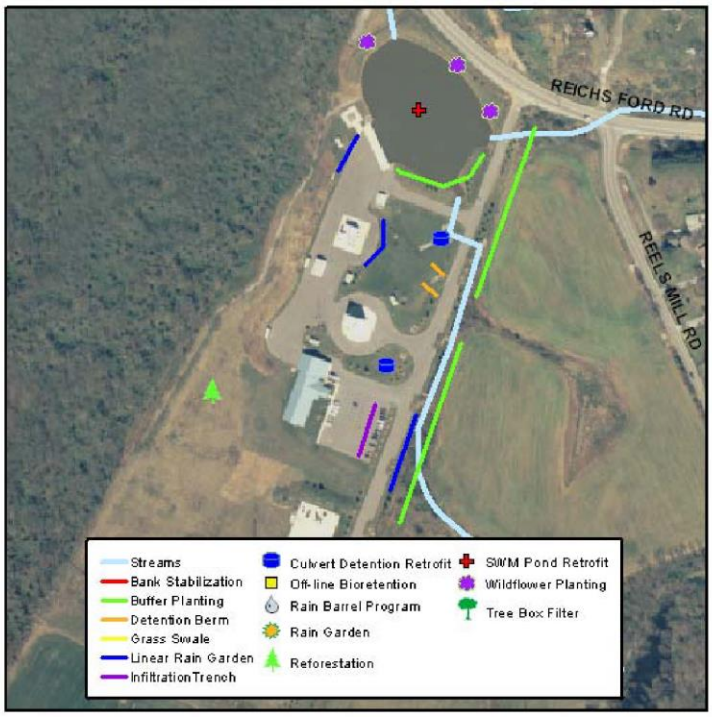
Frederick County Public Safety Training Facility

Project ID:	BA101	**Total Score:**	67
Project Name:	Frederick County Public Safety Training Facility	**Project Type:**	SWM Pond Retrofit
Location:	Reichs Ford Road	**Subwatershed:**	Bartonsville
Ownership:	Frederick County Division of Fire & Rescue Services	**Drainage Area:**	16.9 acres

Site Description:

The County's Public Safety Training Facility is utilized by both fire and police services for training activities. Although runoff is captured by a SWM pond, the design of the pond predates current control standards. Additionally, on-site County personnel reported sediment deposition and algae problems in the existing SWM pond and associated runoff collection system.

Site Map:



Proposed location for a culvert detention retrofit

Sediment deposition in the SWM facility

Proposed Action:

Upgrade control structure for Structure No. 123 (extended detention wet pond) to MD2000 standards and add sediment forebay to pond; place culvert retrofits at two roads; build detention berms and linear rain gardens near training areas; add infiltration trench to parking lot; plant wildflower and forested buffer around pond and along stream; and reforest unused open space on hillside.

Benefits: Improve stormwater quantity controls.
Improve stormwater quantity controls.
Opportunity for public education.

Pond and LID retrofits will provide additional detention capacity, greater peak flow reduction, better groundwater recharge, and improved water quality

Frederick County Public Safety Training Facility

Project ID: BA101

Project Name: Frederick County Public Safety Training Facility

Key Issues for Implementation:

Project Sequencing: Expansion of the training facility is anticipated to begin in fall 2006 with construction of a 3-story building and parking for 300 cars. Retrofits should be integrated into this facility expansion effort.

Known Utilities and Other Constraints: Water lines and other utilities were observed throughout the site. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Infiltration Trench	155	LF	$177	$27,435
Linear Rain Garden	4069	SF	$18	$73,242
Reforestation	0.43	AC	$7,542	$3,243
Buffer Planting	0.27	AC	$7,542	$2,036
SWM Pond Retrofit	9500	SF	$27	$256,500
Detention Berm	116	LF	$4	$464
Wildflower Planting	0.13	AC	$5,324	$692
Replace Culvert	2	EA	$17,745	$35,490
		Estimated Project Cost:		**$400,000**

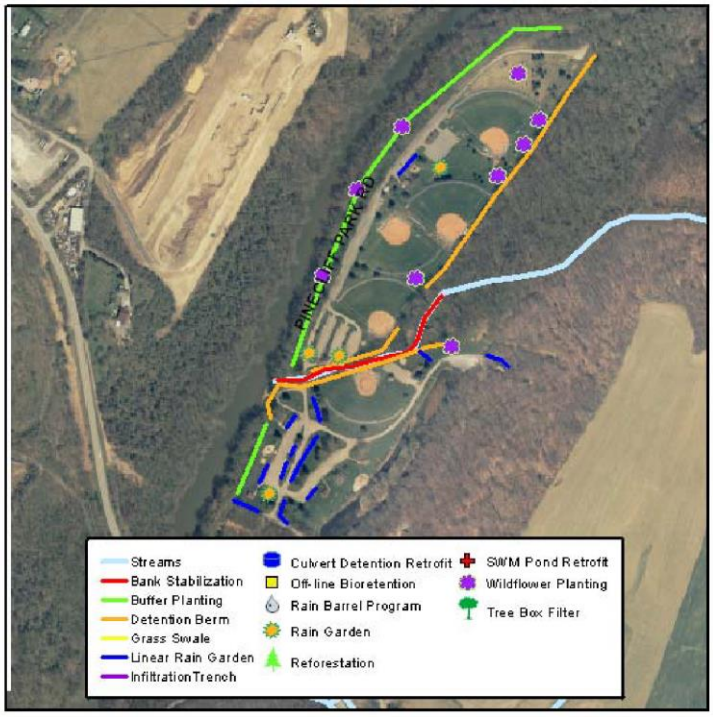
Pinecliff Park - LID

Project ID:	BA102	**Total Score:**	69
Project Name:	Pinecliff Park - LID	**Project Type:**	LID
Location:	Pinecliff Park Road	**Subwatershed:**	Bartonsville
Ownership:	Frederick County Department of Parks and Recreation	**Drainage Area:**	46.4 acres

Site Description:

Pinecliff Park encompasses approximately 50-acres along the east bank of the Monocacy River. The park provides extensive recreational opportunities for baseball (5 fields), picnicking, boat access to the river, playgrounds, and winter sledding and ice skating. Runoff from the lawn, field, and parking areas drains directly to several small streams and to the river. Eroded streambanks were noted along the small streams. Underground water lines beneath the stream and along the east side of the park were being upgraded in early 2006. No stormwater management controls currently exist at this facility.

Site Map:



Proposed location for streambank stabilization

Proposed location for a linear rain garden

Proposed Action:

Stabilize approximately 1,000 ft. of streambank; construct linear rain gardens along parking lot and road margins; place rain gardens in three parking lots; add detention micro-berm along stream and woods; buffer enhancement along Monocacy River; plant wildflowers on sledding hill (mow before sledding season); and plant wildflowers on top of sewer and water lines, and in unused open spaces.

Benefits: Provide stormwater quantity controls.
Provide stormwater quality controls.
Improve stream stability, erosion, and instream habitat.
Improve floodplain and nutrient cycling functions.
Opportunity for public education.

Pinecliff Park - LID

Project ID: BA102

Project Name: Pinecliff Park - LID

Key Issues for Implementation:

Project Sequencing: Implementation of streambank stabilization and other LID retrofit measures should be conducted after the water line project has been completed.

Known Utilities and Other Constraints: Sanitary sewer and water lines are located at or near several project element locations. Other underground utilities, including electric, are present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Bank Stabilization	930	LF	$177	$164,610
Detention Berm	2945	LF	$4	$11,780
Linear Rain Garden	11238	SF	$18	$202,284
Rain Garden	4199	SF	$18	$75,582
Buffer Planting	0.68	AC	$7,542	$5,129
Wildflower Planting	2.43	AC	$5,324	$12,937
		Estimated Project Cost:		**$473,000**

FCDPW Jacobs Run SWM Facility

Project ID:	BB102	**Total Score:**	63
Project Name:	FCDPW Jacobs Run SWM Facility	**Project Type:**	SWM Pond Retrofit
Location:	Jacobs Court	**Subwatershed:**	Bens Branch
Ownership:	Frederick County Department of Highways and Transportation	**Drainage Area:**	1.5 acres

Site Description:

The Frederick County Department of Highways and Transportation owns an oil and grit separator located at the end of Jacobs Court. Runoff currently enters the separator via grass swales adjacent to the road.

Site Map:

Oil and grit separator with potential linear rain garden locations along Jacobs Court

Oil and grit separator, facing southwest.

Proposed Action:

Retrofit oil and grit separator with an off-line bioretention facility below the outfall; install linear rain gardens in grass swales along edges of Jacobs Court.

Benefits: Provide stormwater quantity controls.
Improve stormwater quality controls.

FCDPW Jacobs Run SWM Facility

Project ID: BB102

Project Name: FCDPW Jacobs Run SWM Facility

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities may be present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Linear Rain Garden	3000	SF	$18	$54,000
Off-line Bioretention	491	SF	$21	$10,311
		Estimated Project Cost:		**$65,000**

Catoctin View Subdivision - LID

Project ID:	BB104	**Total Score:**	61
Project Name:	Catoctin View Subdivision - LID	**Project Type:**	LID
Location:	Catoctin View Drive	**Subwatershed:**	Bens Branch
Ownership:	Frederick County Department of Highways and Transportation	**Drainage Area:**	48.5 acres

Site Description:

Construction of the Catoctin View Subdivision predated the use of stormwater management controls. Grass swales, located within the County's road rights-of-way, currently transport stormwater runoff.

Site Map:

Proposed location for a linear rain garden

Proposed location for a linear rain garden

Proposed Action:

Retrofit existing roadside swales with linear rain gardens throughout the subdivision.

Benefits: Improve stormwater quantity controls.
Improve stormwater quality controls.
Opportunity for public education.

Catoctin View Subdivision - LID

Project ID: BB104

Project Name: Catoctin View Subdivision - LID

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities may be present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Rain Garden	3317	SF	$18	$59,706
Linear Rain Garden	48360	SF	$18	$870,480
			Estimated Project Cost:	**$931,000**

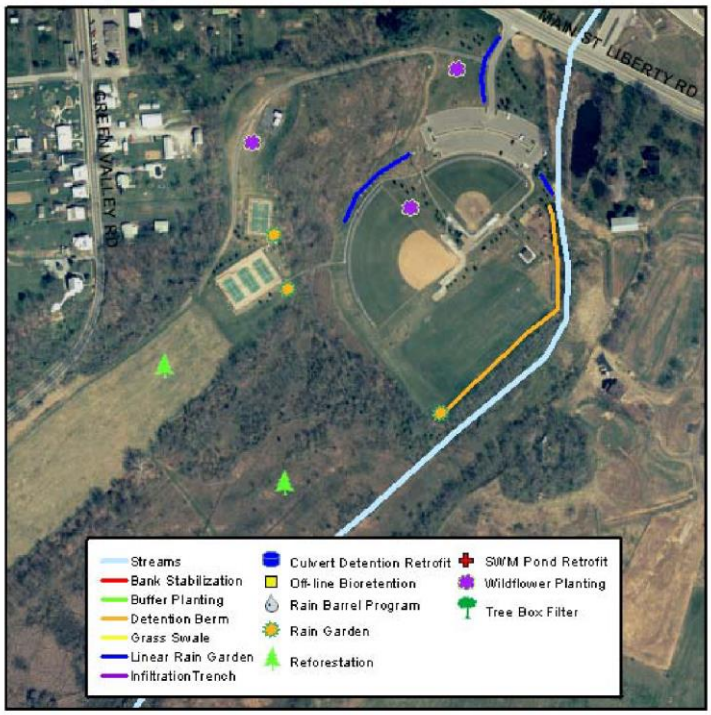
Libertytown Community Park - LID

Project ID:	CB101	**Total Score:**	63
Project Name:	Libertytown Community Park - LID	**Project Type:**	LID
Location:	MD 26	**Subwatershed:**	Coppermine Branch
Ownership:	Frederick County Department of Parks and Recreation	**Drainage Area:**	24.9 acres

Site Description:

Developed portions of the Libertytown Community Park encompass approximately 25-acres in Libertytown. The park provides many recreational opportunities, including baseball and other athletic fields, tennis and basketball courts, a playground, and other activities. Runoff from the lawn, field, and parking areas drains eastward to a small stream. Stormwater runoff is largely uncontrolled at this location.

Site Map:



Potential location for a linear rain garden along park entrance road

Potential location for a linear rain garden along the swale draining westward from the parking lot

Proposed Action:

Retrofit park facilities by installing linear rain gardens along the entrance drive, and in swales at the east and west sides of the parking lot; build rain gardens for tennis and basketball courts, and the southeast corner of the athletic field; add a detention micro-berm along the stream; and plant wildflowers and trees in unused open spaces.

Benefits:
Improve stormwater quantity controls.
Improve stormwater quality controls.
Improve floodplain and nutrient cycling functions.
Opportunity for public education.
Reforestation of unused lawn areas would reduce maintenance costs, provide wildlife habitat and other ecosystem benefits, and improve aesthetics.

Libertytown Community Park - LID

Project ID: CB101

Project Name: Libertytown Community Park - LID

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Electric, water, and sewer lines are located at or near several project element locations. These lines present only a minor constraint and can be avoided by adjusting designs. Other underground utilities may be present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Wildflower Planting	0.5	AC	$5,324	$2,662
Reforestation	1.6	AC	$7,542	$12,067
Rain Garden	9736	SF	$18	$175,248
Linear Rain Garden	5250	SF	$18	$94,500
Detention Berm	714	LF	$4	$2,856
		Estimated Project Cost:		**$288,000**

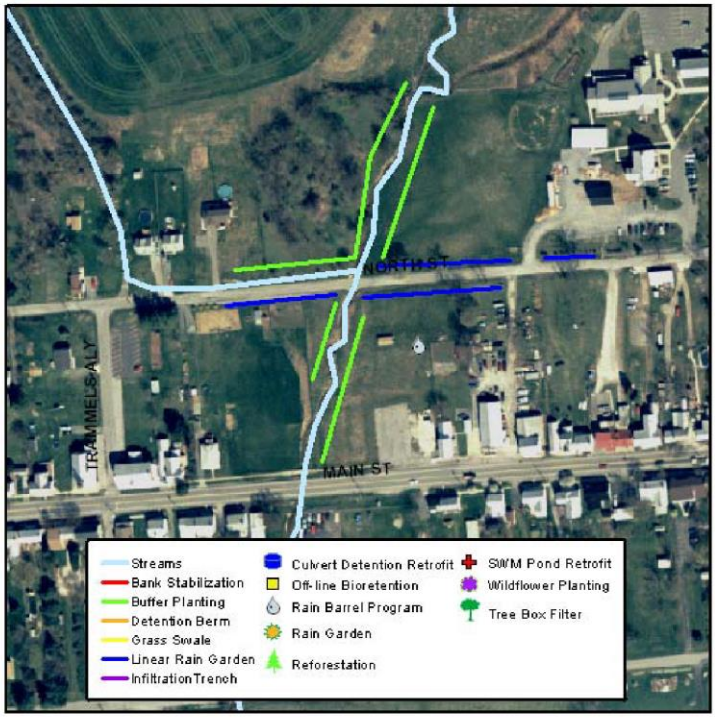
North Street - LID

Project ID:	CB107	**Total Score:**	66
Project Name:	North Street - LID	**Project Type:**	LID
Location:	North Street at Coppermine Branch through Libertytown	**Subwatershed:**	Coppermine Branch
Ownership:	Frederick County Department of Highways and Transportation	**Drainage Area:**	23.5 acres

Site Description:

Most of the development within Libertytown predates the use of stormwater management controls. Runoff from North Street enters Coppermine Branch via a roadside grass swale. Large open areas with inadequate riparian buffer are also located along the stream. This area was identified in the Lower Monocacy WRAS as Project Sites 15 and 16.

Site Map:



Proposed location for linear rain garden

Proposed location for targeting Backyard Buffers

Proposed Action:

Work within County road rights-of-way to install linear rain gardens in roadside swales along North Street and creation of a wildflower buffer along roadside stream. In addition, support LID assistance programs on private property (e.g., Backyard buffer program, rain barrel coupon program, technical assistance for rain gardens).

Benefits: Provide stormwater quantity controls.
Provide stormwater quality controls.
Improve stream stability, erosion, and instream habitat.
Improve floodplain and nutrient cycling functions.
Opportunity for public education.

North Street - LID

Project ID: CB107
Project Name: North Street - LID

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: A sanitary sewer line crosses beneath the proposed buffer location; plantings in this area should be limited to non-woody vegetation. Although no other indication of potential utility constraints was noted at project element locations, additional underground utilities may be present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Buffer Planting	0.29	AC	$7,542	$2,187
Rain Barrel Program	20	Dwelling	$562	$11,240
Linear Rain Garden	8250	SF	$18	$148,500
		Estimated Project Cost:		**$162,000**

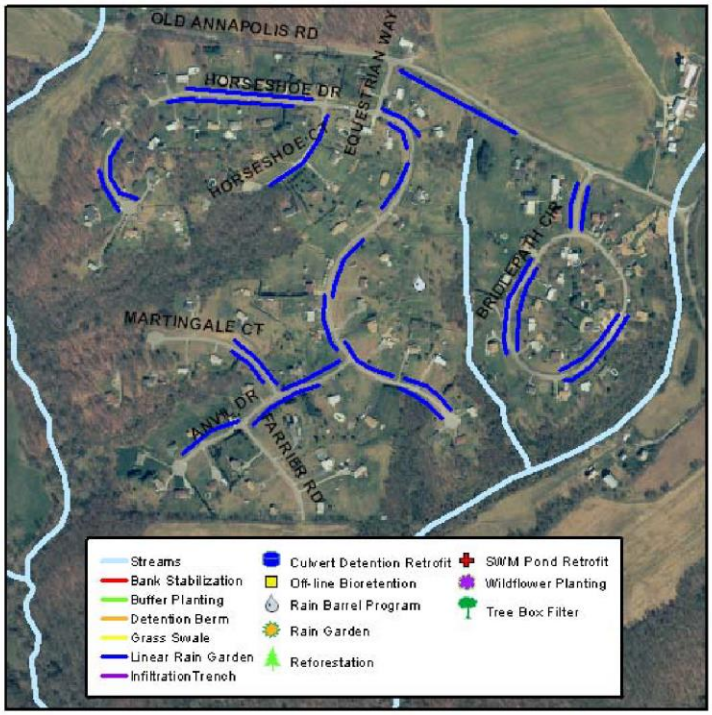
Horseshoe Farms Estates - LID

Project ID:	HF107	**Total Score:**	65
Project Name:	Horseshoe Farms Estates - LID	**Project Type:**	LID
Location:	Equestrian Way, Bridle Path, and Old Annapolis Road	**Subwatershed:**	Horseshoe Farms
Ownership:	Frederick County Department of Highways and Transportation	**Drainage Area:**	57.9 acres

Site Description:

Construction of the Horseshoe Farms Estates Subdivision predated the use of stormwater management controls. Grass swales, located within the County's road rights-of-way, currently transport stormwater runoff. Public interest in this area was noted during the project's February 23, 2006 public workshop.

Site Map:



Proposed location for linear rain garden along Bridle Path Circle

Proposed location for linear rain garden along Horseshoe Court

Proposed Action:

Retrofit existing roadside swales with linear rain gardens throughout the subdivision. Provide outreach and technical assistance to homeowners for rain barrels and rain gardens on private property.

Benefits: Improve stormwater quantity controls.
Improve stormwater quality controls.
Opportunity for public education.

Horseshoe Farms Estates - LID

Project ID: HF107

Project Name: Horseshoe Farms Estates - LID

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities may be present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Rain Barrel Program	35	Dwelling	$562	$19,670
Linear Rain Garden	94500	SF	$18	$1,701,000
		Estimated Project Cost:		**$1,721,000**

Deer Crossing Elementary School

Project ID:	HR101	**Total Score:**	61
Project Name:	Deer Crossing Elementary School	**Project Type:**	SWM Pond Retrofit
Location:	Boyers Mill Road	**Subwatershed:**	Hazelnut Run
Ownership:	Frederick County Board of Education	**Drainage Area:**	24.2 acres

Site Description:

The Deer Crossing Elementary School property is approximately 24 acres in size. The grounds contain extensive impervious surfaces, including parking lots, sidewalks, and roofs, with most of the remaining areas consisting of maintained lawns and athletic fields. Although runoff is captured by a SWM pond, the design of the pond predates current control standards.

Site Map:

Existing SWM pond

Proposed location for linear rain garden along school entrance drive

Proposed Action:

Upgrade control structure for Structure No. 600 (extended detention pond) to MD2000 standards; reforest unused grass areas; install linear bioretention along Finn Drive and school entrance; place rain gardens near basketball court and baseball field; and create a detention micro-berm along the southeast margin of playing fields.

Benefits: Improve stormwater quantity controls.
Improve stormwater quality controls.
Opportunity for public education.

Pond and LID retrofits will provide additional detention capacity, greater peak flow reduction, better groundwater recharge, and improved water quality

Deer Crossing Elementary School

Project ID: HR101

Project Name: Deer Crossing Elementary School

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities are present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
SWM Pond Retrofit	7700	SF	$27	$207,900
Detention Berm	798	LF	$4	$3,192
Linear Rain Garden	22400	SF	$18	$403,200
Reforestation	0.48	AC	$7,542	$3,620
Rain Garden	7483	SF	$18	$134,694
		Estimated Project Cost:		**$753,000**

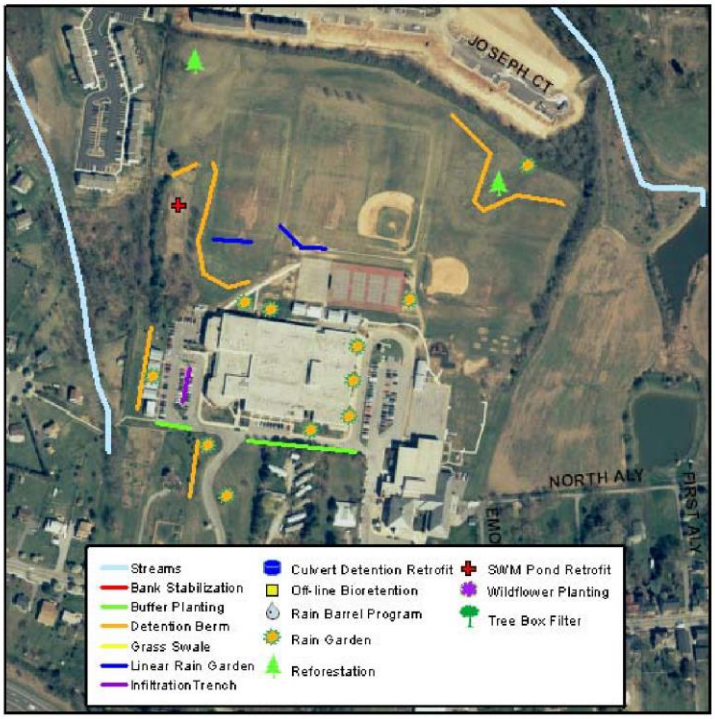
New Market Middle School

Project ID:	HR102	**Total Score:**	60
Project Name:	New Market Middle School	**Project Type:**	LID
Location:	Main St.	**Subwatershed:**	Hazelnut Run
Ownership:	Frederick County Board of Education	**Drainage Area:**	24.0 acres

Site Description:

The New Market Middle School property is approximately 24 acres in size. The grounds contain extensive impervious surfaces, including parking lots, sidewalks, and roofs, with most of the remaining areas consisting of maintained lawns and athletic fields. Runoff from part of the site is captured by a SWM dry pond; the design of the pond predates current control standards.

Site Map:



Existing dry detention area

Potential location for infiltration trench along edge of parking lot

Proposed Action:

Retrofit control structure of dry detention pond to MD2000 standards, incorporating multi-cell bioretention areas in the pond bottom; build rain gardens in lawn areas, around building, and next to paved areas; install infiltration trench in parking lot; add detention micro-berms in lawn areas; and reforest unused open space.

Benefits: Improve stormwater quantity controls.
Provide stormwater quality controls.
Opportunity for public education.

Pond and LID retrofits will provide additional detention capacity, greater peak flow reduction, better groundwater recharge, and improved water quality

New Market Middle School

Project ID: HR102

Project Name: New Market Middle School

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Water lines are located at or near several project element locations. Other underground utilities, including electric, are present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Detention Berm	1620	LF	$4	$6,480
SWM Pond Retrofit	12000	SF	$27	$324,000
Reforestation	0.9	AC	$7,542	$6,788
Buffer Planting	0.12	AC	$7,542	$905
Infiltration Trench	150	LF	$177	$26,550
Linear Rain Garden	2000	SF	$18	$36,000
Rain Garden	9690	SF	$18	$174,420
		Estimated Project Cost:		**$576,000**

New Market Elementary School

Project ID:	HR103	**Total Score:**	60
Project Name:	New Market Elementary School	**Project Type:**	LID
Location:	Main St.	**Subwatershed:**	Hazelnut Run
Ownership:	Frederick County Board of Education	**Drainage Area:**	6.1 acres

Site Description:

The New Market Elementary School property is approximately 6 acres in size. The grounds contain extensive impervious surfaces, including parking lots, sidewalks, and roofs, with most of the remaining areas consisting of maintained lawns and a playground. No stormwater management controls currently exist at this facility.

Site Map:

Potential rain garden location in front of school

Potential location for off-line bioretention garden

Proposed Action:

Construct rain gardens in lawn areas, around building, and next to paved areas; install infiltration trench in parking lot; build off-line bioretention garden at outfall; and build a detention micro-berm in the lawn area along east property line.

Benefits: Provide stormwater quantity controls.
Provide stormwater quality controls.
Opportunity for public education.

New Market Elementary School

Project ID: HR103

Project Name: New Market Elementary School

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities are present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Infiltration Trench	150	LF	$177	$26,550
Off-line Bioretention	1227	SF	$21	$25,767
Rain Garden	5738	SF	$18	$103,284
Detention Berm	207	LF	$4	$828
		Estimated Project Cost:		**$157,000**

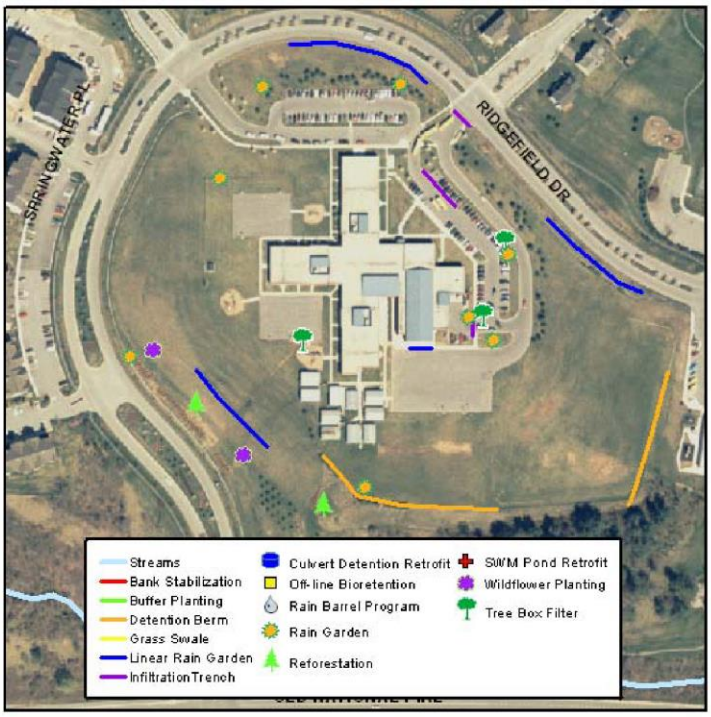
Spring Ridge Elementary School

Project ID:	LB102	**Total Score:**	66
Project Name:	Spring Ridge Elementary School	**Project Type:**	LID
Location:	Ridgefield Drive	**Subwatershed:**	Long Branch
Ownership:	Frederick County Board of Education	**Drainage Area:**	22.6 acres

Site Description:

The Spring Ridge Elementary School property is approximately 23 acres in size. The grounds contain extensive impervious surfaces, including parking lots, sidewalks, and roofs, with most of the remaining areas consisting of maintained lawns, playgrounds, and athletic fields. Stormwater runoff from the site is routed to a large SWM pond in the Spring Ridge development. No on-site stormwater management controls currently exist at this facility.

Site Map:



Replace stormdrain inlet with a tree box filter

Divert roof drains to a linear rain garden along edge of parking lot

Proposed Action:

Install rain gardens, infiltration trenches, and tree box filters in drive and parking areas; place a detention micro-berm along edge of playing fields; add linear rain gardens in roadside swales; build rain gardens in the northwest and southwest lawns; and plant unused open space with trees and wildflowers.

Benefits: Improve stormwater quantity controls.
Improve stormwater quality controls.
Opportunity for public education.

On-site SWM controls will provide additional detention capacity in the downstream SWM facility, provide greater peak flow reduction, better groundwater

Spring Ridge Elementary School

Project ID: LB102

Project Name: Spring Ridge Elementary School

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities are present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Rain Garden	30051	SF	$18	$540,918
Reforestation	0.35	AC	$7,542	$2,640
Tree Box Filter	2	EA	$13,309	$26,618
Infiltration Trench	263	LF	$177	$46,551
Wildflower Planting	0.43	AC	$5,324	$2,289
Linear Rain Garden	9406	SF	$18	$169,308
Detention Berm	700	LF	$4	$2,800
		Estimated Project Cost:		**$792,000**

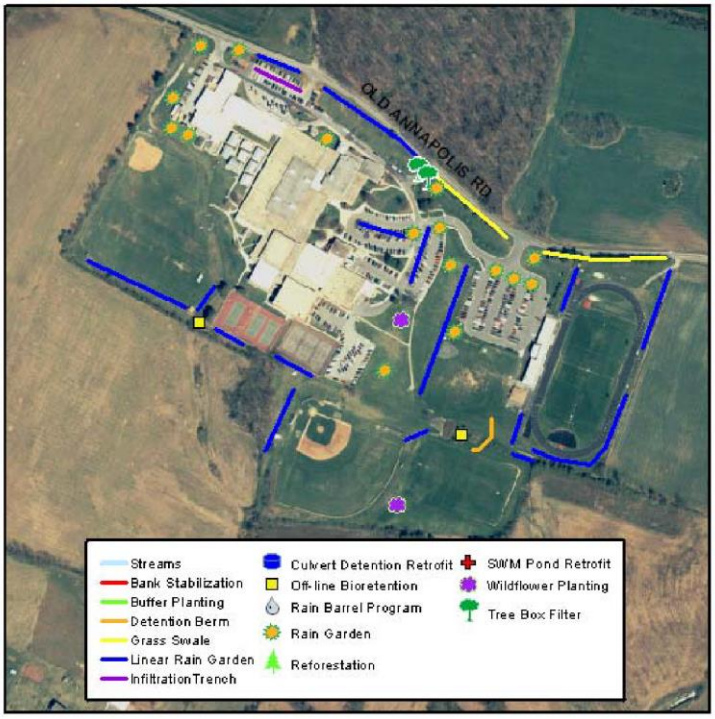
Linganore High School

Project ID:	NL102	**Total Score:**	75
Project Name:	Linganore High School	**Project Type:**	LID
Location:	Old Annapolis Road	**Subwatershed:**	New London
Ownership:	Frederick County Board of Education	**Drainage Area:**	40.2 acres

Site Description:

The Linganore High School property is approximately 40 acres in size. The grounds contain extensive impervious surfaces, including parking lots, sidewalks, and roofs, with most of the remaining areas consisting of maintained lawns and athletic fields. No on-site stormwater management controls currently exist at this facility.

Site Map:



Potential location for linear rain garden in parking island

Potential location for linear rain garden along tennis courts

Proposed Action:

Install linear rain gardens along Old Annapolis Road, in parking lots, and next to athletic fields; place rain gardens around parking lots; provide off-line bioretention at two outfalls; place detention micro-berms across drainage pathways; and plant wildflowers and trees in unused open space.

Benefits: Provide stormwater quantity controls.
Provide stormwater quality controls.
Opportunity for public education.

Linganore High School

Project ID: NL102

Project Name: Linganore High School

Key Issues for Implementation:

Project Sequencing: School staff noted that the school is scheduled for renovation in approximately two years. Retrofits should be integrated into this facility renovation effort.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities are present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Wildflower Planting	0.25	AC	$5,324	$1,331
Tree Box Filter	2	EA	$13,309	$26,618
Infiltration Trench	175	LF	$177	$30,975
Detention Berm	150	LF	$4	$600
Off-line Bioretention	4555	SF	$21	$95,655
Grass Swale	625	LF	$11	$6,875
Linear Rain Garden	34130	SF	$18	$614,340
Rain Garden	31951	SF	$18	$575,118
		Estimated Project Cost:		**$1,352,000**

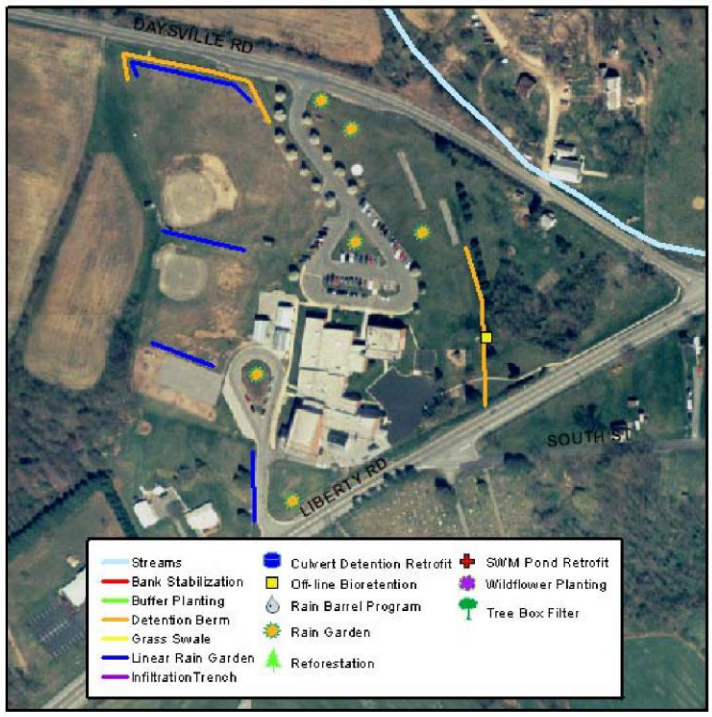
Liberty Elementary School

Project ID:	TO105	**Total Score:**	72
Project Name:	Liberty Elementary School	**Project Type:**	LID
Location:	Liberty Road	**Subwatershed:**	Town Branch
Ownership:	Frederick County Board of Education	**Drainage Area:**	10.3 acres

Site Description:

The Liberty Elementary School property is approximately 11 acres in size. The grounds contain extensive impervious surfaces, including parking lots, sidewalks, and roofs, with most of the remaining areas consisting of maintained lawns, playgrounds, and athletic fields. A rain garden was installed in the northeast lawn area in early 2006.

Site Map:



Provide off-line bioretention garden at outfall below playground

Potential location for rain gardens along Daysville Road entrance

Proposed Action:

Install linear and area rain gardens in traffic islands and landscape beds around school; build off-line bioretention garden below culvert outfall; place detention micro-berm along field margins; and provide linear rain gardens next to athletic fields.

Benefits: Improve stormwater quantity controls.
Improve stormwater quality controls.
Opportunity for public education.

Liberty Elementary School

Project ID: TO105

Project Name: Liberty Elementary School

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities are present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Detention Berm	7000	LF	$4	$28,000
Off-line Bioretention	1818	SF	$21	$38,178
Linear Rain Garden	630	SF	$18	$11,340
Rain Garden	12907	SF	$18	$232,326
		Estimated Project Cost:		**$310,000**

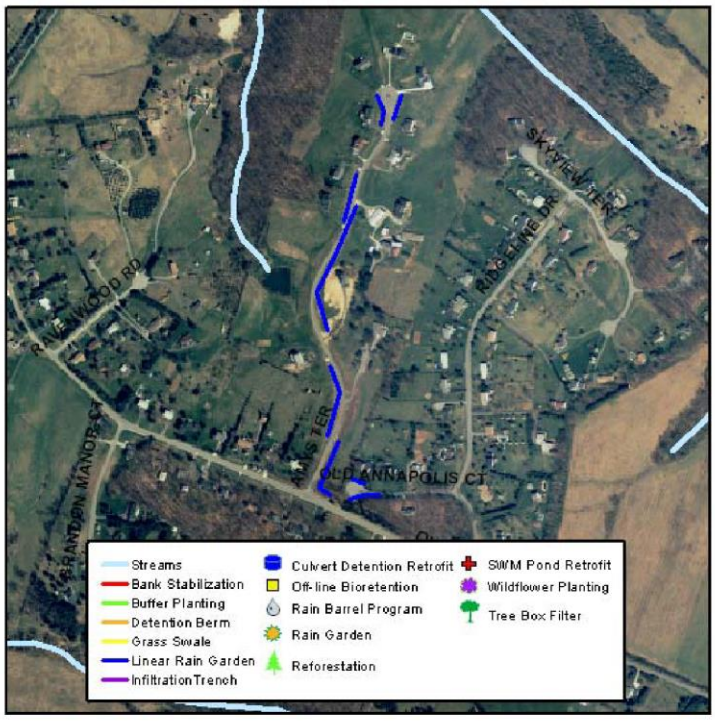
Willow Pond Estates - LID 2

Project ID:	WB111	**Total Score:**	66
Project Name:	Willow Pond Estates - LID 2	**Project Type:**	LID
Location:	Amys Terrace	**Subwatershed:**	Woodville Branch
Ownership:	Frederick County Department of Highways and Transportation	**Drainage Area:**	20.3 acres

Site Description:

The Willow Pond Estates Subdivision lacks SWM facilities to control runoff. Runoff flows through grass swales to stormdrain piping that discharges without controls. The grass swales are located within the County's road rights-of-way. This area was identified in the Lower Monocacy WRAS as Project Site 7.

Site Map:



Potential location for a linear rain garden

Potential location for a linear rain garden

Proposed Action:

Retrofit existing roadside swales with linear rain gardens throughout the subdivision.

Benefits: Improve stormwater quantity controls.
Improve stormwater quality controls.
Opportunity for public education.

Willow Pond Estates - LID 2

Project ID: WB111

Project Name: Willow Pond Estates - LID 2

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities may be present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Linear Rain Garden	22031	SF	$18	$396,558
		Estimated Project Cost:		**$397,000**

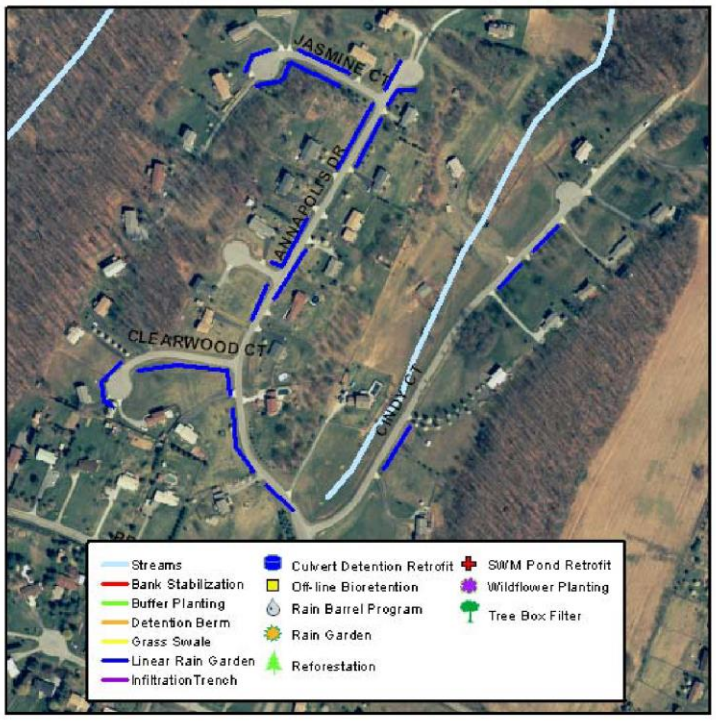
New Estates Subdivision - LID 2

Project ID:	WB113	**Total Score:**	69
Project Name:	New Estates Subdivision - LID 2	**Project Type:**	LID
Location:	Cindy Court and North Annapolis Drive	**Subwatershed:**	Woodville Branch
Ownership:	Frederick County Department of Highways and Transportation	**Drainage Area:**	15.5 acres

Site Description:

Large portions of the New Estates Subdivision do not have stormwater management controls. Grass swales, located within the County's road rights-of-way, currently transport stormwater runoff. This area was identified in the Lower Monocacy WRAS as Project Site 5.

Site Map:



Potential location for a linear rain garden

Potential location for a linear rain garden

Proposed Action:

Retrofit existing roadside swales with linear rain gardens throughout the subdivision.

Benefits: Improve stormwater quantity controls.
Improve stormwater quality controls.
Opportunity for public education.

New Estates Subdivision - LID 2

Project ID: WB113

Project Name: New Estates Subdivision - LID 2

Key Issues for Implementation:

Project Sequencing: Implementation may be performed at any time.

Known Utilities and Other Constraints: Although no indication of potential utility constraints was noted in the field at project element locations, underground utilities may be present. Specific utility locations need to be determined.

Planning Level Cost Estimate:

Item Description	Quantity	Units	Unit Cost	Total
Linear Rain Garden	28566	SF	$18	$514,188
		Estimated Project Cost:		**$515,000**

4.2 TIER 2 CANDIDATE SITES

The following 22 additional candidate sites represent good opportunities for the County or their partners to implement watershed restoration projects, including improvements to stormwater management (Table 4-4).

Table 4-4. Summary and ranking of candidate Tier 2 CIP watershed restoration opportunities in Linganore Creek.

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Estimated Project Cost	Total Score
CIP Tier 2								
TO106	Town Branch	LID	Winter Springs Subdivision - LID	Arlington Mill Road	Public - County ROW/Easement	Convert roadside swale to linear rain gardens; Backyard Buffer program.	$432,000	56
DE104	Detrick	LID	Mt. Airy Overview Estates - LID	Corporal Jones Court	Public - County ROW/Easement	Convert roadside swales to linear rain gardens.	$720,000	55
WB112	Woodville Branch	LID	Ravenswood Estates - LID	Ridgeline Drive	Public - County ROW/Easement	Roadside swale to linear rain gardens.	$540,000	54
LB112	Long Branch	LID	Oakdale Elementary School	MD 144	Public - County owned	Increase SWM pond capacity via rain gardens in traffic/landscape islands, infiltration trenches in parking lots, and tree box filters; reforest unused lawn areas.	$173,000	54
NL104	New London	LID	Woodspring at New Market - LID	Meadow Way	Public - County ROW/Easement	Linear rain gardens along road; rain garden in traffic circle.	$288,000	54
LB113	Long Branch	LID	Oakdale Middle School	MD 144	Public - County owned	Increase SWM pond capacity via rain gardens in traffic/landscape islands, infiltration trenches in parking lots, and tree box filters; reforest unused lawn areas.	$268,000	52
WB110	Woodville Branch	LID	Prospect View Subdivision - LID	Annapolis Court	Public - County ROW/Easement	Roadside swale to linear rain gardens.	$396,000	51
NL103	New London	LID	Meadows at New Market - LID	Barngate Circle	Public - County ROW/Easement	Curb cuts and linear rain gardens along road; tree box filters at storm drain inlets.	$175,000	50
LB101	Long Branch	LID	Winter Oaks Place - LID 2	Winter Oaks Place	Public - County owned	Rain garden in traffic circle at north end of Winter Oaks Place; and off-line bioretention at stormwater pipe outfall.	$77,000	48
LB108	Long Branch	LID	Spring Ridge - LID 9	Ridgefield Drive at Long Branch	Public - County ROW/Easement	Convert roadside swales to linear rain gardens. Work with HOA to enhance buffer along stream.	$182,000	46
LB109	Long Branch	LID	Spring Ridge - LID 8	Spring Ridge Drive at Long Branch	Public - County ROW/Easement	Convert roadside swales to linear rain gardens; two tree box filters at intersection. Work with HOA to enhance buffer along stream.	$155,000	45
BB103	Bens Branch	LID	White Oak Subdivision - LID	Almeria Court and Niagara Drive	Public - County ROW/Easement	Linear rain gardens in roadside swales in subdivision.	$360,000	45
HR110	Hazelnut Run	LID	New Market West - LID	Royal Oak Drive	Public - County ROW/Easement	Replace 11 storm drain inlets with tree box filters.	$147,000	42
LB121	Long Branch	LID	Prestwich Terrace - LID 2	Prestwich Terrace	Public - County ROW/Easement	Linear rain gardens in roadside swales along Prestwich Terrace and Holly Hills Drive	$126,000	41
LB120	Long Branch	LID	Prestwich Terrace - LID 1	Prestwich Terrace	Public - County ROW/Easement	Linear rain gardens in roadside swales; rain garden in traffic circle at end of Prestwich Terrace.	$522,000	41

Table 4-4. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Estimated Project Cost	Total Score
CIP Tier 2								
LB115	Long Branch	LID	Ritchie Court - LID	Ritchie Court	Public - County ROW/Easement	Linear rain gardens in roadside swales.	$90,000	40
LB107	Long Branch	LID	Spring Ridge - LID 1	Spring Ridge south of I-70	Public - County ROW/Easement	Tree box filters at approx. 10 storm drain inlets.	$134,000	39
LB118	Long Branch	LID	Pebble Beach Terrace - LID	Pebble Beach Terrace, Pebble Beach Court, Berwick Place N	Public - County ROW/Easement	8 tree box filters.	$107,000	38
LB116	Long Branch	LID	Ritchie Drive - LID	Ritchie Drive and Carnoustie Place	Public - County ROW/Easement	Linear rain gardens in roadside swales.	$720,000	38
LL215	Linganore Creek - lower mainstem	LID	Summerfield - LID 1	Douglas Ave.	Public - County ROW/Easement	Four tree box filters; work with HOA to install linear and area rain garden in open space.	$98,000	37
LL214	Linganore Creek - lower mainstem	LID	Greenview Subdivision - LID	Meyer Ave and Whiterose Drive	Public - County ROW/Easement	Install linear rain gardens between sidewalks and road.	$233,000	32
LL210	Linganore Creek - lower mainstem	LID	Spring Ridge - LID 5	Newport Drive west	Public - County ROW/Easement	Tree box filters - 3	$40,000	29

4.3 COMMUNITY RESTORATION SITES

The following 130 candidate sites represent opportunities for watershed restoration via the County's Community Restoration partners (Table 4-5). At a number of sites, the opportunity and need for improvements are similar to the Tier 1 sites; however, these sites are not likely to be eligible for implementation under the County's CIP. Most of these sites are located on private land and would require further coordination with local property owners.

Table 4-5. Summary and ranking of candidate Community Restoration opportunities in Linganore Creek

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
LL218	Linganore Creek - lower mainstem	LID	Lake Linganore CDA - LID	Lake Linganore CDA	Public - Unknown (e.g., HOA, open space)	Rain barrel coupon program. Technical assistance and funding program for LID on private property. Set up lake buffer program to improve lawn care practices and promote tall grass/forested buffer along lake edge.	N/A	$29,000	76
CB103	Coppermine Branch	Agricultural Program	Farm Lots - Agricultural BMP 2	Green Valley Road, West side	Private	Establish buffer; provide livestock fencing along stream; WRAS Project Site 12.	7,420	$52,000	64
DE102	Detrick	Stream Restoration	Lime Plant Road - Stream Stabilization 1	Lime Plant Road	Private	Grade and stabilize steep stream banks; fence livestock out of stream; plant riparian buffer; provide alternate livestock watering and crossing; enhance/protect existing wetlands; and examine opportunity for wetland mitigation banking.	2,380	$991,000	64
TO101	Town Branch	Agricultural Program	Fox Pass - Agricultural BMP	Artie Kemp Road	Private	Stream buffer and livestock fencing; WRAS Project Site 21.	5,200	$32,000	63
WC107	Weldon Creek	Agricultural Program	Woodville Road - Agricultural BMP	Woodville Road	Private	Stream buffer.	8,930	$27,000	63
CB104	Coppermine Branch	Agricultural Program	Hood Farm - Agricultural BMP 1	Green Valley Road, West side	Private	Establish buffer; provide livestock fencing along stream; WRAS Project Site 13.	6,640	$37,000	62
CB106	Coppermine Branch	Agricultural Program	Hood Farm - Agricultural BMP 3	Green Valley Road, East side	Private	Establish buffer; WRAS Project Site 14.	4,730	$15,000	62
CB102	Coppermine Branch	Agricultural Program	Farm Lots - Agricultural BMP 1	Green Valley Road, East side	Private	Establish buffer along stream; WRAS Project Site 11.	4,500	$14,000	61
NL107	New London	Stream Restoration	Lime Plant Road - Stream Stabilization 2	Lime Plant Road	Private	Grade and stabilize steep stream banks; fence livestock out of stream; plant riparian buffer; provide alternate livestock watering and crossing; enhance/protect existing wetlands; and examine opportunity for wetland mitigation banking.	5,720	$2,272,000	61
NL111	New London	Stream Restoration	Gas House Pike - Stream Stabilization	11600 Gas House Pike	Private	Grade and stabilize steep stream banks; fence livestock out of stream; plant riparian buffer; provide alternate livestock watering and crossing; treat barnyard runoff.	2,860	$1,173,000	61
NF102	North Fork	Stream Restoration	Woodville Road - Stream Stabilization	8600 block Woodville Road	Private	Grade and stabilize steep stream banks; fence livestock out of stream; plant riparian buffer; provide alternate livestock watering and crossing; and enhance/protect existing wetlands; examine opportunity for wetland mitigation banking.	3,780	$724,000	61

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
TO104	Town Branch	Agricultural Program	Gaver Farm - Agricultural BMP 3	8900 block Green Valley Road	Private	Stream buffer and livestock fencing; WRAS Project Site 19b.	5,980	$38,000	61
WB101	Woodville Branch	Agricultural Program	Old Bohn Road - Agricultural BMP 1	5800 block Old Bohn Road	Private	Stream buffer; livestock fencing; WRAS Project Site 1.	4,870	$35,000	60
HF103	Horseshoe Farms	Agricultural Program	Farm and Farmettes - Agricultural BMP	Bridle Path Circle and Old Annapolis Road at Chestnut Grove Road	Private	Stream buffer; livestock fencing.	5,470	$28,000	59
TO102	Town Branch	Agricultural Program	Artie Kemp Road - Agricultural BMP 2	Artie Kemp Road	Private	Stream buffer enhancement; WRAS Project Site 20.	4,520	$14,000	59
CG105	Chestnut Grove	Agricultural Program	Cassis Farm - Agricultural BMP	Alton Road	Private	Enhance buffer along north bank of Linganore Creek, and along both sides of side tributary.	2,590	$8,000	55
NF105	North Fork	Agricultural Program	Dollyhyde Road - Agricultural BMP 3	8000 block Dollyhyde Road	Private	Stream buffer; livestock fencing.	6,600	$47,000	55
TA104	Talbot Branch	Stream Restoration	Emerson Burrier Road - Stream Stabilization	Emerson Burrier Road	Private	Grade and stabilize steep stream banks; fence livestock out of stream; plant riparian buffer; provide alternate livestock watering and crossing; enhance/protect existing wetlands; examine opportunity for wetland mitigation banking; and WRAS Project Site 40.	3,080	$571,000	55
TO103	Town Branch	Agricultural Program	Sach Farm - Agricultural BMP	8900 block Green Valley Road	Private	Buffer enhancement; WRAS Project Site 19.	1,350	$5,000	55
BB101	Bens Branch	Agricultural Program	Bens Branch - Agricultural BMP	Bens Branch North of Detrick Road	Private	Buffer enhancement; livestock fencing.	5,210	$29,000	54
DE101	Detrick	Agricultural Program	Miller Farm - Agricultural BMP 1	12600 block Old Annapolis Road	Private	Plant riparian buffer; fence livestock out of stream.	4,390	$31,000	54
WB102	Woodville Branch	Agricultural Program	Old Bohn Road - Agricultural BMP 2	6300 block Old Bohn Road	Private	Stream buffer; livestock fencing; WRAS Project Site 2.	1,620	$11,000	54

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
BA109	Bartonsville	LID	Winding Oaks Park - LID	Winding Oaks Court	Public - Unknown (e.g., HOA, open space)	Linear bioretention garden in park swale; rain garden at outfall.	N/A	$72,000	53
HR104	Hazelnut Run	LID	New Market - LID	Town of New Market	Private	Rain barrel coupon program; technical assistance and funding program for LID on private property.	N/A	$34,000	52
NL105	New London	LID	Westwinds Tennis Pavilion - LID	Wimbledon Court	Public - Unknown (e.g., HOA, open space)	Linear rain garden along back side of tennis pavilion; reforest open space; culvert retrofit between parking lots; rain garden and tree box filter at inlets.	N/A	$306,000	52
NF107	North Fork	LID	Unionville - LID	Unionville Road	Private	Backyard buffers; rain barrel education and coupon program.	N/A	$14,000	51
UL104	Linganore Creek - upper mainstem	Agricultural Program	Glisan Farms - Agricultural BMP 1	Annapolis Road	Private	Stream buffer; livestock fencing.	1,310	$10,000	50
WC106	Weldon Creek	Agricultural Program	Unionville Road - Agricultural BMP	Albaugh and Unionville Roads	Private	Stream buffer; livestock fencing.	2,440	$18,000	50
CB105	Coppermine Branch	Agricultural Program	Hood Farm - Agricultural BMP 2	Woodsboro Road	Private	Establish buffer; WRAS Project Site 13b.	2,490	$8,000	49
CB108	Coppermine Branch	LID	Liberty East - LID	Liberty East	Private	Rain barrel coupon program; Backyard Buffer program; WRAS Project Site 17.		$9,000	49
LL204	Linganore Creek - lower mainstem	Agricultural Program	Mercer/Toms Farms - Agricultural BMP	West side of Linganore Road	Private	Stream buffer; livestock fencing; and treat barnyard runoff.	6,570	$64,000	49
SF109	South Fork	Agricultural Program	Resourceful Acres - Agricultural BMP	7100 block Kimmell Road	Private	Stream buffer; livestock fencing; WRAS Project Site 8	2,490	$18,000	49
SF111	South Fork	LID	Lauer/Sabelhaus - Wetland enhancement and buffer	5000 Buffalo Road	Private	Enhance existing wetland with more suitable native vegetation; establish buffer along stream below wetlands	1,450	$16,000	49
UL102	Linganore Creek - upper mainstem	Agricultural Program	Glissans Mill Road - Agricultural BMP 1	12500 block Glissans Mill Road	Private	Stream buffer; livestock fencing.	6,500	$46,000	48

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
NL108	New London	Agricultural Program	Peace & Plenty Farm - Agricultural BMP	6400 Green Valley Road	Private	Stream buffer; livestock fencing.	4,610	$33,000	48
NL110	New London	Agricultural Program	Miller Farm - Agricultural BMP 2	Drummine Road	Private	Stream buffer; livestock fencing.	3,860	$28,000	48
WB107	Woodville Branch	Agricultural Program	Ickes Farm - Agricultural BMP	Shirely Bohn Road	Private	Buffer along headwaters of stream; WRAS Project Site 10.	1,800	$6,000	48
DE103	Detrick	Stream Restoration	Barnett Drive - Stream Stabilization	Barnett Drive	Private	Grade and stabilize steep stream banks; fence livestock out of stream; plant riparian buffer; provide alternate livestock watering and crossing; and treat barnyard runoff.	2,470	$1,039,000	47
LB110	Long Branch	LID	Spring Ridge Shopping Center - LID	Spring Ridge Drive	Private	Install rain gardens in landscape and traffic islands around building and parking lot perimeter; infiltration trenches in parking lots; tree box filters in stormdrain inlets.	N/A	$316,000	47
NL101	New London	Agricultural Program	Detrick Road - Agricultural BMP	5700 block Detrick Road	Private	Stream buffer; livestock fencing.	9,360	$61,000	47
NL109	New London	Agricultural Program	Green Valley Road - Agricultural BMP	6200 block Green Valley Road	Private	Stream buffer; livestock fencing. Remove fish passage blockage.	4,830	$43,000	47
TA103	Talbot Branch	Agricultural Program	Talbot Run Road - Agricultural BMP	UT along 7800 block Talbot Run Road	Private	Stream buffer; livestock fencing; WRAS Project Site 39.	2,630	$13,000	47
NF101	North Fork	Agricultural Program	Loew Vineyards - Agricultural BMP	Liberty Road	Private	Stream buffer.	5,780	$18,000	46
BA110	Bartonsville	Agricultural Program	Lohr Property - Agricultural BMP	8527 Reichs Ford Rd	Private	Provide assistance with agricultural BMP programs, including volunteer restoration measures	1,220	$1,000	45
BA107	Bartonsville	LID	Country Squire Subdivision - Rain Barrel Program	Bartonsville Road	Private	Rain barrel education and coupon program.	N/A	$23,000	45
LB104	Long Branch	LID	Long Branch - Rain Barrel Program	Long Branch Subwatershed	Private	Community rain barrel coupon and stormwater education program.	N/A	$17,000	45
WC101	Weldon Creek	Agricultural Program	Barnes Road - Agricultural BMP 1	Barnes Road	Private	Stream buffer; livestock fencing.	4,140	$29,000	45

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
WB103	Woodville Branch	Agricultural Program	Kraft Farm - Agricultural BMP	Buffalo Road	Private	Stream buffer; WRAS Project Site 1b.	1,410	$5,000	45
DC105	Dollyhyde Creek	Agricultural Program	Sithens Farm - Agricultural BMP	Timmons Road	Private	Enhance riparian buffer; fence livestock out of stream.	7,500	$50,000	44
SF103	South Fork	Agricultural Program	Tressler Farm - Agricultural BMP	11600 block Glissans Mill Road	Private	Stream buffer; livestock fencing.	4,200	$30,000	44
BA108	Bartonsville	SWM Pond Retrofit	Winter Oaks Place - LID 1	Winter Oaks Place	Public - Unknown (e.g., HOA, open space)	Convert old sediment basin/pond structure near end of stormwater pipe outfall to off-line bioretention structure.	N/A	$27,000	43
DC106	Dollyhyde Creek	Agricultural Program	Gaver Farm - Agricultural BMP 1	Timmons Road	Private	Enhance riparian buffer; fence livestock out of stream.	5,890	$36,000	43
LL206	Linganore Creek - lower mainstem	LID	Woodridge - LID	Woodridge development	Public - Unknown (e.g., HOA, open space)	Linear rain gardens along road edges.	N/A	$1,008,000	43
UL103	Linganore Creek - upper mainstem	LID	Spilman Farm/MD75 runoff - LID	7808 Green Valley Road	Private	LID to control runoff from MD75/Green Valley Road onto private property.	N/A	$18,000	43
SF102	South Fork	Agricultural Program	Burrier Knob - Agricultural BMP	Glissans Mill Road	Private	Stream buffer; livestock fencing.	5,350	$38,000	43
WB105	Woodville Branch	Agricultural Program	F & N Farm - Agricultural BMP	Bohn Road	Private	Stream buffer; WRAS Project Site 6.	2,390	$8,000	43
CG107	Chestnut Grove	LID	Chestnut Grove Road - LID	Vicinity of 8039 Chestnut Grove Road	Private	Neighborhood rain barrel coupon and installation program; technical assistance for rain gardens.	N/A	$9,000	42
LL213	Linganore Creek - lower mainstem	LID	Oak Acres - LID	White Oak Drive	Private	Rain barrel education and coupon program.	N/A	$17,000	42
LB103	Long Branch	LID	MD 144 - Abandoned Roadbed LID	MD 144 - east of Monocacy	Public - Other Entity	Remove old abandoned lanes of MD 144, approx. 3,500' x 50' and reforest.	N/A	$431,000	42

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
NL112	New London	Agricultural Program	Baltimore Presbytery - Agricultural BMP	6600 New London Road	Private	Provide assistance with CREP program to replace non-profitable farming	760	$1,000	42
LL209	Linganore Creek - lower mainstem	LID	Spring Ridge - LID 6	Newport Drive west	Public - Unknown (e.g., HOA, open space)	Off-line bioretention garden at two pipe outfalls; sediment forebay to Structure No. 458; rain gardens in two existing stormwater detention cells; and linear rain gardens in roadside swales along Spring Ridge Drive.	N/A	$225,000	41
LB106	Long Branch	Agricultural Program	Long Branch - Agricultural BMP	Long Branch west of Ijamsville Road	Private	Buffer enhancement.	6,190	$19,000	41
WB104	Woodville Branch	LID	New Estates Subdivision - LID 1	Cindy Court	Private	Backyard buffer program; WRAS Project Site 5.	2,100	$8,000	41
BB106	Bens Branch	Agricultural Program	Runkles Farm - Agricultural BMP	5514 Woodville Rd	Private	Assist landowner with horse farm management, including tree planting and watering.	N/A	$1,000	40
BB107	Bens Branch	Agricultural Program	Hurst Farm - Agricultural BMP	13791 Helane Court, Mt. Airy, MD 21771	Private	Assistance with livestock (horses) management and related conservation programs; buffer enhancement	N/A	$4,000	40
DC101	Dollyhyde Creek	Agricultural Program	Coppermine Road Farms - Agricultural BMP	12400 Coppermine Road	Private	Enhance riparian buffer.	3,970	$12,000	40
DC104	Dollyhyde Creek	Agricultural Program	Dollyhyde Road - Agricultural BMP 2	Dollyhyde Road	Private	Plant riparian buffer.	3,640	$11,000	40
HR109	Hazelnut Run	Agricultural Program	Archibald Farm - Agricultural BMP	Green Valley Road	Private	Stream buffer; livestock fencing.	5,350	$32,000	40
LL103	Linganore Creek - lower mainstem	Agricultural Program	Gas House Pike - Agricultural BMP 3	10400 block Gas House Pike	Private	Stream buffer; livestock fencing.	4,570	$24,000	40
NF106	North Fork	Agricultural Program	Glissan Place - Agricultural BMP	8300 block Dollyhyde Road	Private	Stream buffer; livestock fencing.	1,930	$14,000	40
SF110	South Fork	LID	Isaac Walton League - LID	Woodville Road	Private	Buffer along stream; reforest unused open areas.	840	$16,000	40

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
WC104	Weldon Creek	Stream Restoration	Horton Farm - Stream Stabilization	14900 block Liberty Road	Private	Bank stabilization; stream buffer.	1,520	$270,000	40
LL207	Linganore Creek - lower mainstem	Agricultural Program	Farm - Agricultural BMP 2	Linganore Creek at Plantation Road	Private	Enhance buffer along mainstem.	3,470	$6,000	39
LB114	Long Branch	LID	Holly Hills - LID	Ijamsville Road and Ritchie Way	Private	Linear rain garden in swale along Ritchie Way; rain gardens in lawn area at culvert openings along Ijamsville Road; buffer and wildflower meadow in open space below SWM pond berm.	N/A	$291,000	39
SF107	South Fork	Agricultural Program	Glisan Farms - Agricultural BMP 2	Annapolis Road	Private	Stream buffer; livestock fencing.	2,100	$15,000	39
TA101	Talbot Branch	Agricultural Program	Black Ankle Road - Agricultural BMP	14800 block Black Ankle Road	Private	Stream buffer; livestock fencing.	5,310	$36,000	39
WC103	Weldon Creek	Agricultural Program	Barnes Road - Agricultural BMP 3	Barnes Road, south of Oak Orchard Road	Private	Stream buffer; livestock fencing.	2,530	$16,000	39
CG103	Chestnut Grove	Agricultural Program	Alton Road - Agricultural BMP 1	Alton Road	Private	Add buffer to left fork of stream; improve buffer on right fork up to Alton Road.	3,090	$10,000	38
HR108	Hazelnut Run	Agricultural Program	Charlyn Farm - Agricultural BMP	Boyers Mill Road	Private	Stream buffer.	4,830	$15,000	38
LL101	Linganore Creek - lower mainstem	Agricultural Program	Gas House Pike - Agricultural BMP 1	10000 block Gas House Pike	Private	Stream buffer.	3,360	$11,000	38
LL208	Linganore Creek - lower mainstem	LID	Spring Ridge - LID 4	Spring Forest Road	Public - Unknown (e.g., HOA, open space)	Add off-line bioretention gardens along length of grass swale prior to entering detention pond and at outfall by Spring Ridge Drive; reforest unused open space.	N/A	$194,000	38
OB101	Oldfield Branch	Agricultural Program	Liberty Road - Agricultural BMP	Liberty Road	Private	Stream buffer.	1,940	$6,000	38
WB109	Woodville Branch	LID	Audubon Society of Central MD - LID	Old Annapolis Road	Private	Reforest unused open areas.	N/A	$31,000	38

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
LL217	Linganore Creek - lower mainstem	LID	Steamboat Way North - LID	Steamboat Way North	Public - Unknown (e.g., HOA, open space)	Off-line bioretention gardens at two outfalls.	N/A	$64,000	37
LB105	Long Branch	LID	Winding Ridge Way - LID	Winding Ridge Way and Baltimore Road	Private	Supplement existing OGS with infiltration trench along Winding Ridge between road and sidewalks; add linear rain garden along Baltimore Rd.	N/A	$163,000	37
NL106	New London	Agricultural Program	Traylor Farm - Agricultural BMP	6602 New London Road	Private	Stream buffer; livestock fencing.	2,670	$19,000	37
NF103	North Fork	Agricultural Program	Burrier Farm - Agricultural BMP 3	Clemsonville Road	Private	Stream buffer.	2,510	$8,000	37
NF104	North Fork	Agricultural Program	Mapleville Road - Agricultural BMP	8800 block Mapleville Road	Private	Stream buffer; livestock fencing.	2,980	$21,000	37
WC102	Weldon Creek	Agricultural Program	Barnes Road - Agricultural BMP 2	Barnes Road at Loel Road	Private	Stream buffer; livestock fencing.	2,290	$17,000	37
WE102	Westwinds	Agricultural Program	Old Annapolis Road - Agricultural BMP 2	Between Central Church Road and Old Annapolis Road	Private	Stream buffer; livestock fencing.	3,000	$16,000	37
WB106	Woodville Branch	LID	Willow Pond Estates - LID 1	Amys Terrace	Private	Backyard Buffer; WRAS Project Site 7.	1,120	$8,000	37
CG104	Chestnut Grove	Agricultural Program	Alton Road - Agricultural BMP 2	Alton Road	Private	Buffer enhancement.	1,840	$6,000	36
HF101	Horseshoe Farms	Agricultural Program	Liberty Road Farm - Agricultural BMP	Liberty Road at Chestnut Grove Road	Private	Stream buffer.	3,720	$12,000	36
LL205	Linganore Creek - lower mainstem	Agricultural Program	Farm - Agricultural BMP 1	Tributaries (2) to Lower Linganore mainstem on north side	Private	Buffer enhancement.	3,950	$12,000	36

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
LL201	Linganore Creek - lower mainstem	LID	Spring Ridge - LID 2	Spring Ridge Drive south of I-70	Public - Unknown (e.g., HOA, open space)	Add off-line bioretention gardens to two outfalls within catchment for Structure No. 463 (ED dry pond); linear rain gardens along Spring Ridge Drive.	N/A	$155,000	36
SF106	South Fork	Agricultural Program	Kimmell Road - Agricultural BMP	7100 block Kimmell Road	Private	Stream buffer.	2,380	$8,000	36
CG106	Chestnut Grove	Agricultural Program	Chestnut Grove - Agricultural BMP	SE of intersection of Chestnut Grove and Liberty Road	Private	Buffer enhancement.	2,760	$9,000	35
DC102	Dollyhyde Creek	Agricultural Program	Baker Farm - Agricultural BMP	Fountain School Road	Private	Plant riparian buffer.	2,480	$8,000	35
DC103	Dollyhyde Creek	Agricultural Program	Dollyhyde Road - Agricultural BMP 1	Dollyhyde Road	Private	Enhance riparian buffer.	2,400	$8,000	35
HR105	Hazelnut Run	Agricultural Program	L. Blentlinger Farm - Agricultural BMP	Boyers Mill Road	Private	Stream buffer; livestock fencing.	1,210	$9,000	35
HF104	Horseshoe Farms	Agricultural Program	McKaig Road - Agricultural BMP	McKaig Road, NE of Keyser	Private	Stream buffer.	3,390	$11,000	35
HF105	Horseshoe Farms	Agricultural Program	Burrier Farm - Agricultural BMP 1	10600 block. Liberty Road	Private	Stream buffer; address barnyard runoff.	1,180	$14,000	35
LL102	Linganore Creek - lower mainstem	Agricultural Program	Gas House Pike - Agricultural BMP 2	10200 block Gas House Pike	Private	Stream buffer.	2,630	$8,000	35
LL202	Linganore Creek - lower mainstem	LID	Spring Ridge - LID 3	Ridgefield Circle	Public - Unknown (e.g., HOA, open space)	Add off-line bioretention gardens to five outfalls within catchment for Structure No. 462 (ED dry pond).	N/A	$128,000	35
DC107	Dollyhyde Creek	Agricultural Program	Gaver Farm - Agricultural BMP 2	Timmons Road	Private	Enhance riparian buffer; fence livestock out of stream.	1,480	$7,000	34
LL104	Linganore Creek - lower mainstem	Agricultural Program	Gas House Pike - Agricultural BMP 4	10600 block Gas House Pike	Private	Stream buffer; livestock fencing.	2,520	$18,000	34

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
SF108	South Fork	Agricultural Program	Shippen Farm - Agricultural BMP	Buffalo Road	Private	Stream buffer.	2,690	$9,000	34
HR106	Hazelnut Run	Agricultural Program	W. Blentlinger Farm - Agricultural BMP	Boyers Mill Road and Finn Drive	Private	Stream buffer; livestock fencing.	3,150	$23,000	33
LL216	Linganore Creek - lower mainstem	SWM Pond Retrofit	Summerfield - LID 2	Huckleberry Way	Public - Unknown (e.g., HOA, open space)	Retrofit Structure No. 309 (ED dry pond) control structure to meet MD2000 standards and three bioretention cells.	N/A	$27,000	33
WE101	Westwinds	Agricultural Program	Old Annapolis Road - Agricultural BMP 1	Old Annapolis Road (north side)	Private	Stream buffer; filter strips along drainage from barn; remediate fish barrier at crossing.	1,360	$39,000	33
BA106	Bartonsville	Agricultural Program	Aylor Drive - Agricultural BMP	Aylor Drive	Private	Stream buffer.	1,240	$4,000	32
CG102	Chestnut Grove	Agricultural Program	Artie Kemp Road - Agricultural BMP 1	Artie Kemp Road south of Liberty Road	Private	Buffer enhancement.	2,020	$7,000	32
HF102	Horseshoe Farms	Agricultural Program	View More Heights - Agricultural BMP	Serenity Court	Private	Stream buffer.	3,350	$11,000	32
HF106	Horseshoe Farms	Agricultural Program	Burrier Farm - Agricultural BMP 2	10600 block. Liberty Road	Private	Stream buffer; address barnyard runoff.	1,180	$4,000	32
UL101	Linganore Creek - upper mainstem	Agricultural Program	Smith and Beall Farms - Agricultural BMP	8000 block Green Valley Road	Private	Stream buffer; livestock fencing.	2,470	$18,000	32
SF101	South Fork	Agricultural Program	Potomac Estates - Agricultural BMP	13800 block Harrisville Road	Private	Stream buffer.	2,130	$7,000	32
SF104	South Fork	Agricultural Program	Snowmill Farm - Agricultural BMP	Buffalo Road	Private	Stream buffer.	2,210	$7,000	32
WC105	Weldon Creek	Agricultural Program	Albaugh Road - Agricultural BMP	9200 block Albaugh Road	Private	Stream buffer; livestock fencing.	1,020	$8,000	32

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
CG101	Chestnut Grove	SWM Pond Retrofit	Libertytown Shopping Center - SWM Pond Retrofit	11400 block. Liberty Road	Private	Upgrade control structure for Structure No. 85 (dry pond) to MD2000 standards, including bioretention pretreatment. Install rain gardens along strip between parking lot and Liberty Rd to capture highway runoff.	N/A	$80,000	31
HR107	Hazelnut Run	Agricultural Program	Justron Farm - Agricultural BMP	Boyers Mill Road and New Market Court	Private	Stream buffer; livestock fencing.	2,120	$15,000	31
LB111	Long Branch	LID	Meadow Road - LID	Meadow Road	Private	Backyard buffer in residential area.	1,100	$8,000	31
BA104	Bartonsville	SWM Pond Retrofit	River Oaks - SWM Pond Retrofit	Winding Oak Court	Public - Unknown (e.g., HOA, open space)	Upgrade control structure for Structure No. 16 (dry pond) to MD2000 standards; and wildflower plantings in open space below weir.	N/A	$28,000	30
LL203	Linganore Creek - lower mainstem	Stream Restoration	City of Frederick, Filtration Plant	Linganore Road	Public - Other Entity	Grade and stabilize steep banks; buffer and tree planting in open space along creek.	2,530	$452,000	30
LB117	Long Branch	LID	Holly Hills Turf Care Center - LID	Ritchie Drive	Private	Install one linear and two area rain gardens below SWM pond outfall.	N/A	$54,000	30
LB119	Long Branch	LID	Fairwinds Section 2 - LID	Royal St and Andrews Place	Private	Add linear rain gardens to swales conveying water to pond; off-line bioretention along pond margin.	N/A	$122,000	30
LB122	Long Branch	LID	Eaglehead Information Center (former location)	Eaglehead Drive	Private	Linear rain gardens in roadside swales; plant wildflowers and forest in unused open spaces.	N/A	$121,000	30
LL212	Linganore Creek - lower mainstem	LID	Parking lot at Lake Linganore Dam	Eaglehead Drive at Linganore Cr	Public - Unknown (e.g., HOA, open space)	Detention micro-berm along parking lot margin; rain garden in grassy area below pump house.	N/A	$19,000	29
SF105	South Fork	Agricultural Program	Linganore Winecellars - Agricultural BMP	13600 Glissans Mill Road	Private	Stream buffer.	1,230	$4,000	28
BB105	Bens Branch	Stream Restoration	Bens Branch - Fish Passage	Bens Branch above Hope Valley Golf Course	Private	Remove fish passage barrier.	260	$27,000	27

Table 4-5. (Continued)

Project ID	Subwatershed	Project Type	Project Name	Location	Ownership	Project Description	Approx. Project Length (ft)	Estimated Project Cost	Total Score
LL211	Linganore Creek - lower mainstem	SWM Pond Retrofit	Spring Ridge - LID 7	Newport Drive east	Public - Unknown (e.g., HOA, open space)	Retrofit Structure No. 94 (ED dry pond) with off-line bioretention.	N/A	$32,000	27

5.0 TIER 1 CIP PROJECTS – BENEFITS AND COST

Additional analysis of the Tier 1 projects was conducted to estimate the anticipated water quality benefits, as well as relative costs, for each candidate CIP project. The benefit and cost of each project varies because underlying watershed conditions, in addition to site specific conditions and constraints, have determined the potential locations and practice types for various project elements at each site.

5.1 MODELED BENEFIT OF TIER 1 PROJECTS

As described in Appendix A, estimates of pollutant load reductions associated with each project have been calculated to guide project selection. These reductions have also been aggregated to provide an estimate of the benefit at the catchment level, which represents the overall benefit to Linganore Creek should all the Tier 1 projects be constructed.

At the catchment level, implementation of all Tier 1 projects is anticipated to provide a modest reduction in pollutant loads (Table 5-1). For example, reduction of total phosphorus load ranges from 0.3% to 9.5% per year. Reduction of total phosphorus and the other water quality parameters varies due to the area treated and the combination of practice types proposed for the sites.

To further examine the benefit of each project, specific load reductions in pounds per year have been calculated for the project locations (Table 5-2).

5.2 COST-BENEFIT ANALYSIS OF TIER 1 CIP PROJECTS

An analysis of the cost to benefit ratio for these projects helps to identify which projects would provide the largest pollutant load reductions at the lowest cost. Total phosphorus, total nitrogen, and total suspended sediment have been used in the cost-benefit analysis (Table 5-3). These ratios represent the unit cost for pollutant removal in dollars/pound/year. While these costs may appear high, project life spans are expected to be 20 years or longer, and when costs are factored over a longer period, unit costs are substantially lower.

Table 5-1. Percent reduction in catchment loads from all Tier 1 projects												
Basin	**Catchment**	**TN**	**TP**	**OP**	**BOD**	**COD**	**TSS**	**PB**	**CU**	**ZN**	**CD**	**Project(s) in catchment**
Lower	BART-A	1.2%	1.2%	-0.1%	1.6%	2.0%	3.2%	1.5%	1.6%	1.9%	3.0%	BA101, BA102
	BART-C	3.4%	3.9%	0.0%	3.7%	6.0%	6.7%	2.3%	4.4%	4.6%	5.3%	BA102
	BB-A	8.0%	9.5%	0.0%	16.1%	17.1%	9.9%	20.7%	7.0%	18.4%	16.4%	BB104
	BB-D	0.3%	0.3%	0.0%	0.5%	0.6%	0.3%	0.6%	0.2%	0.5%	0.6%	BB102
	HF-A	5.2%	7.0%	0.0%	14.3%	16.8%	5.9%	33.8%	3.8%	22.6%	17.1%	HF107
	HF-B	6.5%	8.6%	0.0%	19.3%	22.4%	7.5%	39.8%	5.8%	29.5%	23.3%	HF107
	HR-B	3.4%	3.2%	-0.3%	4.8%	4.7%	5.4%	6.3%	3.6%	5.2%	5.2%	HR101
	HR-F	1.4%	1.9%	0.1%	3.6%	3.4%	2.4%	3.8%	0.8%	3.7%	3.3%	HR102, HR103
	LB-A	3.4%	4.6%	0.4%	9.4%	7.5%	6.3%	9.8%	0.9%	9.8%	7.2%	LB102
	LB-B	0.6%	0.8%	0.1%	1.5%	1.4%	1.0%	1.4%	0.4%	1.4%	1.3%	LB102
	NL-B	1.6%	1.9%	0.1%	5.1%	4.6%	2.4%	8.9%	1.5%	7.4%	4.7%	NL102
	NL-C	3.6%	4.3%	0.1%	10.3%	9.4%	5.9%	17.3%	3.8%	14.3%	9.8%	NL102
Upper	CB-A	2.9%	3.3%	0.0%	6.8%	7.0%	4.3%	9.8%	3.5%	9.0%	6.8%	CB101, CB105, TO105
	TOB-B	0.5%	0.6%	0.0%	1.6%	1.3%	0.7%	2.6%	0.5%	2.2%	1.3%	TO105
	WB-E	1.0%	1.4%	0.0%	2.9%	3.4%	1.1%	6.8%	0.9%	4.4%	3.7%	WB113
	WB-F	2.8%	3.6%	0.0%	7.1%	8.0%	3.3%	12.6%	2.2%	9.9%	8.0%	WB111

Table 5-2. Estimated pollutant removal (lbs/year) for each Tier 1 candidate project

Project	TN	TP	OP	BOD	COD	TSS	PB	CU	ZN	CD
BA101	22.2	2.2	(0.1)	55.1	215	3,785	0.0	0.8	0.2	0.0
BA102	77.2	11.1	-	270	2,064	8,574	0.2	3.3	1.8	0.1
BB102	3.2	0.5	-	20.8	99.7	200	0.0	0.1	0.1	0.0
BB104	104	14.9	-	671	3,207	6,514	0.9	2.6	4.0	0.2
CB101	42.3	6.0	-	166	1,141	4,597	0.1	1.8	1.1	0.1
CB107	81.6	10.2	-	614	2,032	6,295	0.7	2.5	3.6	0.1
HF107	125	18.0	-	814	3,876	7,814	1.1	3.0	4.9	0.2
HR101	88.9	8.9	(0.4)	249	927.0	7,575	0.1	2.5	0.9	0.1
HR102	66.7	10.7	-	755	2,613	5,425	0.8	0.7	4.2	0.1
HR103	18.0	3.3	0.4	218	716.4	1,535	0.3	0.2	1.3	0.0
LB102	67.8	11.2	0.5	812	2,667	5,605	0.9	0.9	4.9	0.1
NL102	154	19.7	0.4	889	3,104	13,484	0.8	3.9	4.2	0.2
TO105	42.9	5.1	-	210	734.9	3,421	0.2	1.2	1.0	0.0
WB111	33.2	4.8	-	216	1,034	2,074	0.3	0.8	1.3	0.1
WB113	43.5	6.3	-	281	1,345	2,752	0.4	1.0	1.7	0.1
Total	970	133	0.7	6,241	25,776	79,649	6.8	25.2	35.2	1.4

Table 5-3. Cost-benefit analysis for Tier 1 candidate projects

Project	Project Name	Estimated Project Cost	Cost-Benefit Ratios		
			Reduction in Total Phosphorus ($/lb/year)	Reduction in Total Nitrogen ($/lb/year)	Reduction in Total Suspended Sediment ($/lb/year)
BA101	Frederick County Public Safety Training Facility	$400,000	$185,359	$18,053	$106
BA102	Pinecliff Park - LID	$473,000	$42,659	$6,123	$55
BB102	FCDPW Jacobs Run SWM Facility	$65,000	$140,726	$20,296	$325
BB104	Catoctin View Subdivision - LID	$931,000	$62,578	$8,956	$143
CB101	Libertytown Community Park - LID	$288,000	$47,908	$6,806	$63
CB107	North Street - LID	$162,000	$15,822	$1,986	$26
HF107	Horseshoe Farms Estates - LID	$1,721,000	$95,773	$13,811	$220
HR101	Deer Crossing Elementary School	$753,000	$85,050	$8,474	$99
HR102	New Market Middle School	$576,000	$53,761	$8,641	$106
HR103	New Market Elementary School	$157,000	$47,715	$8,712	$102
LB102	Spring Ridge Elementary School	$792,000	$70,862	$11,680	$141
NL102	Linganore High School	$1,352,000	$68,462	$8,754	$100
TO105	Liberty Elementary School	$310,000	$61,238	$7,221	$91
WB111	Willow Pond Estates - LID 2	$397,000	$82,844	$11,947	$191
WB113	New Estates Subdivision - LID 2	$515,000	$82,354	$11,847	$187

6.0 SUMMARY AND RECOMMENDATIONS

This study identified 167 site-specific watershed restoration opportunities to improve Linganore Creek's valuable water resources.

Fifteen of these sites, Tier 1 projects, represent substantial opportunities for watershed improvement via implementation through the County's CIP program (Table 4-3). We expect that the County will use our preliminary prioritization, the cost-benefit analysis, and other information to further refine these priorities and select from among these Tier 1 candidates based on additional factors and priorities that would influence successful implementation. As such, it is recommended that the County select a subset of high priority sites to pursue further through subsequent feasibility assessment(s) that would collect additional site-specific information, update ownership information and evaluate landowner cooperation, identify additional project constraints, further refine project approach and design, and determine if additional action is warranted for each high priority candidate site.

Although the Tier 1 sites represent good opportunities, a substantial portion of the watershed problems (i.e., stormwater runoff, pollutant loads, streambank erosion, poor riparian and instream habitat, etc.) originate on private lands, within community open space areas, or in agricultural areas where there is little opportunity for urban stormwater retrofits through the County's CIP. In these cases, opportunities for watershed improvement need to be addressed through alternate avenues for implementation.

It is strongly recommended that the County continue to provide public support for watershed improvements by expanding its current outreach and education, technical assistance, and other efforts to help bring stormwater and watershed management BMPs to uncontrolled areas.

In addition, to further promote projects and programs directed towards stormwater and watershed management improvements on private lands, it is recommended that the County establish an annual program that provides small grants to local watershed organizations, residents, and businesses to help facilitate watershed education, capacity building, small watershed retrofit and restoration projects, and watershed monitoring activities. For example, grants could be used to off-set purchase and installation costs for rain barrels or other LID projects on private property via a coupon program or other sales mechanism, staff time for a watershed organization, or field equipment for a volunteer watershed monitoring program.

The County has been extremely successful in establishing a large network of Community Restoration partners (e.g., non-profit groups, agricultural resource agencies, etc.), and many of the CR and Tier 2 opportunities (Sections 4.2 and 4.3) are ideally suited for implementation by these groups and organizations, which can often leverage additional public support, outside sources of funding, and other resources to put projects "on the ground." Where possible, the County should lend support to these projects and programs.

Finally, we recommend that Frederick County use this list of candidate sites as a guide for selecting and implementing stormwater management and stream improvements. Because the County's priorities may change and other opportunities arise over time, the County should be free to respond accordingly in order to encourage, collaborate, or require improvements at any of the 167 candidate sites, and not just those currently identified in the Tier 1 list.

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APPENDIX A

Stormwater Pollutant Load Modeling: Methods and Results

APPENDIX B

Public Workshop Presentation Materials

DIVISION OF PUBLIC WORKS
FREDERICK COUNTY, MARYLAND
Department of Program Development and Management
118 North Market Street Frederick, Maryland 21701
(301) 694-1413 FAX (301) 694-1808 TDD (301) 694-1672

"Serving with Pride County Wide"

January 23, 2006

Dear Landowner,

I am writing to invite you to a meeting at New Market Elementary School on Thursday, February 23rd from 6:00 to 8:00 pm to hear new Linganore data and help prioritize future restoration projects in the Linganore watershed. The meeting will include at least three elements: First, County watershed management staff and consultants will summarize their recent findings on water quality and stream corridor health in Linganore. Secondly, citizens will help identify locations of problem sites and potential projects. Finally, citizens will be introduced to further opportunities for education, information, and resources for restoration projects such as the Backyard Buffer project and the Bay Wise Yardstick landscape management initiative.

You may also be interested in knowing about three recently funded initiatives in the Linganore watershed: the first, "Holding Our Ground" is an outreach and education initiative that provides information and site visits for selected owners of riparian properties. Information will be offered to interested residents through an E-newsletter, web site and workshops. Site visits will be made to interested landowners of qualifying properties to share analysis of stream corridor, water quality, and possible restoration practices for their properties.

The second initiative called the "Linganore Urban Demonstration Project" provides funding for projects that will reduce phosphorus and sediment in Lake Linganore. More specifically, funding will be used to establish 18 acres of native trees and shrubs along riparian corridors on urban land and construct community restoration projects on an additional 30 acres of urban land. Four community restoration projects are planned, one of which has been constructed, in a related effort called the Libertytown Stewards project funded by the Chesapeake Bay Trust.

You may find more information about the County's watershed management activities and guidance at the County web site http://www.co.frederick.md.us/NPDES/ . You also may be interested in hearing about efforts of our broad group of partners concerned about watershed health, the Monocacy Catoctin Watershed Alliance at www.watershed-alliance.com

We look forward to seeing you on the 23rd. Please contact me if you have any questions about the meeting at smoore@fredco-md.net or 301 694-1413. If you are unable to make the meeting but would like to receive our Watershed E-newsletter, please email or call Kay Schultz kschultz@fredco-md.net or 301 694-1741.

Sincerely,

Shannon Moore

NPDES Project
Manager

Public Workshop to Identify Watershed Restoration Opportunities in Linganore Creek

February 23, 2006 – New Market Elementary School

1. Introduction
   - Project Team introductions
   - Background: protection of watersheds in Frederick County
   - Objectives for the meeting
   - Objectives of the Linganore Creek Watershed Study
2. Main Presentation
   - Overview of current conditions within Linganore Creek watershed
   - Problems affecting streams in the watershed
   - Solutions: types of opportunities for improvements
   - Avenues for implementation of candidate projects
   - Individual and community actions to improve water quality
   - Introduction to the Problem and Opportunity Identification Exercise
3. Problem and Opportunity Identification Exercise
   - Break out into several groups and gather around stations to discuss and suggest public ideas – watershed broken in 3 pieces – Western, Northeastern, and Southeastern
   - Each station will have:
     - A large format map of a portion of Linganore Creek watershed
     - Problem and Opportunity Identification cards to fill out; Project Team staff will plot location on map with the help of those making suggestions
     - Project Team staff with which to discuss problem areas, potential solutions, concerns, etc.

We Appreciate Your Participation!

Project Team:

Frederick County, Division of Public Works		***Versar, Inc.***	
Shannon Moore		Morris Perot	Nancy Roth
Kay Schultz	Jessica Hunicke	Mike Klevenz	Brenda Morgan

For periodic project updates and additional information on the County's efforts to preserve and protect clean water, visit the following web sites:

Frederick County	***Monocacy Catoctin Watershed Alliance***
www.co.frederick.md.us/NPDES	www.watershed-alliance.com

Or, contact: Shannon Moore, Frederick County NPDES Program Coordinator, at (301) 694-1413, or smoore@fredco-md.net.

APPENDIX C

Candidate Watershed Restoration Site Rankings - Detailed Scores

APPENDIX D

Line Item Costs Used in Watershed Restoration Practices